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RESEARCH ARTICLE

Housing Satisfaction among Students in Tertiary Institutions in Calabar, Cross River State, Nigeria

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Abstract
The paper focused on examining the satisfaction of students with hostel accommodation in tertiary institutions in Calabar, Cross River State Nigeria. The study sought specifically to identify the level at which students were satisfied with hostel accommodation using fifteen (15) variables. In order to obtain data, three (3) tertiary institutions within the study area were purposively sampled. A total of 150 copies of questionnaire were distributed to residents in the school hostels. Specifically, 50 copies of questionnaire were distributed in each residential hostel in schools that were sample out. Analysis were done using both descriptive statistics such as frequencies and simple percentages as well as relative satisfaction index (RSI) to determine the level of satisfaction of students in the hostels. A five point Likert scale was adopted in explaining the level of satisfaction of students with the hostels. The findings revealed that the students were fairly satisfied with the quality, condition and general standards of the hostels in the study area. This is due to the fact that certain facilities that need to be on ground to boost satisfaction level of students were not adequately provided. For instance, it was noted that students do not have maximum access to ICT facilities in hostels. It was also revealed that privacy in hostels had the weakest contribution to student satisfaction in the hostels. In order to boost satisfaction of residents with hostel accommodation, it was suggested that hostels be maintained regularly to avoid deterioration of facilities. It was also recommended that more residential units be developed to accommodate students in the study area. Equally, the students' priority should be given concern in the housing development process.

Keywords: Environmental quality Hostel accommodation, housing quality, housing environment, level of satisfaction.

Introduction

Housing is a fundamental need for human beings. It is regarded as a primary human need. Other needs of humans are food and clothing (Akpu and Sarah, 2015). Among the above basic needs of man, housing is ranked second only to food in the daily needs of humans (Ojikpong, Agbor and Emri, 2016). Generally, housing endows it owner with a social identity, thus integrating him with his immediate social milieu. Therefore, owning a house provides significant security and status in the society. Hence, housing has a profound influence on man's health, education, social behaviour, employment, productivity, awareness on development opportunities, safety, crime and general wellbeing. This justifies the fact that housing is more than mere shelter as it encompasses all the social services and utilities that go to make a community or neighbourhood a livable environment (Ojikpong *et al.*, 2016). With housing, spaces for work, sleep, recreation as well as other social requirements are provided. Furthermore, housing units are required for various uses. For instance, in commercial uses, housing units are required for storage of goods as well as for shops and warehouses while in institutional uses, housing units are demanded to serve as administrative complexes and housing units are in high demand for residential purposes. The importance of housing has made access to housing units to remain a fundamental human right (UN Habitat, 2006). In educational institutions specifically, housing units are needed for classrooms, as well as to accommodate teaching and learning equipment/facilities, provide spaces for administration and accommodate staff and students. Against this backdrop, the need for housing units in the school environment cannot be over emphasized.

Even more, housing units are needed for accommodation purposes for students.

Studies from the fields of Education and Humanities have shown positive relationships between students' accommodation and their academic performances. For instance, Etikan, Bala, Babatope, Yuvali and Bakir (2017) observed that the quality and condition of hostels accommodating students had a profound influence on the learning outcome of students in Cyprus. They noted specifically that the housing condition and it settings had serious implications on academic performance of students. In a similar study in Ghana, Zotorvie (2020) showed that proximity to lecture halls, spacious and well ventilated rooms hostels; calm and peaceful environments, availability of study area, accommodation fee, and availability of electricity and water were the critical factors that influenced the students' choice of residential accommodation. He also noted a significant effect between the types of accommodation and academic performance of students. Elsewhere, in Sri Lanka, Mansoor and Ali (2015) observed that the academic performance of students were largely tied to the quality of the hostels and other places of accommodation. They specifically established a positive relationship student academic performance and residential housing quality. In Nigeria, available studies (Bella-Omunagbe, 2015; Ajayi, Nwosu and Ajani, 2015; Ifaturoti, 2017) made similar observations. They reported that students' residential apartments play integral roles in their academic performance. Generally, staying in conducive environments allow students to be healthy enough to face academic exercises with confidence. Health is wealth they say and health of students is largely determined by the quality of the houses and environments that they stay and live in.

Understanding the importance of accommodating students within close proximity to tertiary institutions, some tertiary institutions have made arrangements for the development of hostels for students. Apart from the fact that hostels help students overcome accommodation problems to an extent, there also serve as a means for revenue generation by the institution. For instance, schools that provide hostel accommodation for its students usually attach demand charges before granting access to students to be residents in the hostels. This imply that hostel provision is not only beneficial to the students but it is equally beneficial to the tertiary institutions. However, it is not enough to provide housing for students to reside while pursuing their academics, the quality and condition of the houses play very vital roles in determining habitability of the housing structures. In developing countries, scholars that have questioned the quality of housing units and the facilities that are provided for students (Ubong, 2007; Sawyerr and Yusof, 2013; Odaudu and Yahaya, 2019). Sawyerr and Yusof, (2013) noted a dissatisfaction of polytechnic students with the quality, condition and state of facilities in the hostels while Ubong (2007) noted that despite the fact that hostel development is usually given out as contract to private developers, the quality of the residential apartments together with the facilities that are provided are in Nigerian hostels do not stand the taste of time. As a result, deterioration and dilapidation sets in quickly. In virtually all cases, the carrying capacities of the hostels are exceeded due to overcrowding in rooms by students and deterioration becomes inevitable in such cases. Odaudu and Yahaya (2019) also highlighted that adequate facilities are not provided for students in Nigerian hostel bed rooms. They observed that, storage facilities are lacking and as such, students litter their properties indiscriminately. There is also poor maintenance of hostel facilities further threatening the serenity of hostels in Nigeria. With the assertion that good quality residential accommodation have effect on the academic performance of students and the submission that hostels in Nigeria are becoming derelict and moribund, it is clear that there is need to appraise the facilities, condition and quality of hostels. The need to further appraise the level of satisfaction of students with the hostels that are accommodating them stems from the fact that most students have their origins from distant states and do not have family members to stay with as some could not even afford rent payment for off-campus accommodation. Equally, taking off-campus accommodation is expensive for the average students and most of them cannot afford such. To this end, students end up prioritizing hostel accommodation.

In Calabar, Cross River State, there are several tertiary institutions. For instance, there exist the University of Calabar, University of Cross River, School of Health Technology and School of Nursing among others. These schools have made provision for hostel accommodation for their students. However, the satisfaction of the students with the quality, condition and nature of facilities in the hostels has not been ascertained in available literature. Holistically, the inability of existing studies to appraise the level of satisfaction of hostel students with the housing units they are being accommodated in suggest that there is a gap in knowledge that need to be filled. However, an understanding of the level of satisfaction of students with the housing facilities, it quality and condition will go a long way in enhancing policy statements that will be made towards housing sustainability in the study area. Based on this premise, the paper sets out to assess the level of satisfaction of students with hostel accommodation in Calabar, Cross River State, Nigeria.

Literature Review

Concept of Housing Quality

On a general basis, quality defines the mental and moral attribute of a particular thing (Bichi, Abdu and Adam, 2018). Specifically, it is the quality of a thing that makes it unique

and distinguished. In virtually all cases, the quality that makes up a thing are the features that are used in explaining what the thing is. Furthermore, quality is used in the description of the nature, features, condition or properties and constituents of a particular thing. Therefore, understanding the meaning of quality is dependent on the user, the user's desires/aspirations as well as the understanding of certain factors that goes along to describing the thing. In this regard, quality is a function of the users' desire/aspiration as well as the purpose the product intends to serve (Bichi *et al.,* 2018). Housing quality is regarded as the grade or level of acceptability of dwelling units and their associated and immediate residential environment, including the design and functionality of housing structures, building materials used, the amount of internal and external space pertaining to the dwelling, housing utilities, and basic service provision. Housing quality is further defined by the physical conditions of the buildings together with the facilities and services that make living in a particular area conducive.

Housing quality is a complex concept. It encapsulate the quantitative and qualitative dimensions of residential units, their immediate surroundings, and the needs of the occupants. The concept of housing quality relates to standards and conditions. However, it is primarily concerned with the objective structural, material, social and economic constituents of housing products or outcomes that can be measured and that result from the performance of the housing sector. These factors include considerations such as price, quantity, tenure, economic impacts, environmental impacts, and structural norms of housing standards. In spite of the perspective in which quality of houses may be viewed, it should be such that the housing units satisfies the occupants. For the occupants of the structure to be satisfied, certain variables need to be ascertained such as the building orientation, the size of the rooms, windows and height as well as building lines and setbacks. Furthermore, the definition of quality of housing incorporates the facilities in the building. Therefore, in the development and maintenance of hostels, factors such as physical conditions of the building has to be satisfactorily met in line with established standards and necessary facilities.

Housing Satisfaction

The satisfaction of residents in housing units is a function of variables such as location, facilities and environmental quality. Khan (2021) in his study in Bangladesh employed residential satisfaction index (RSI) in explaining twenty-two variables of four components. The components were social environment, neighborhood environment, public services and facilities, and dwelling units. His results indicated that public services/facilities social environment and neighborhood environment have greater impact on the dwelling units. His findings also showed that the nature of the environment make the younger ones to be more satisfied than the older. Maina (2021) in Gombe used descriptive and inferential statistics in analyzing housing satisfaction. His findings showed that residents of public housing in Gombe were generally dissatisfied with their housing environments. Their dissatisfaction was based on the fact that major housing facilities were lacking. Equally, Onifade, Lawanson and Adewale (2018) in Lagos observed that number of rooms occupied, types of building are the sustainable housing satisfaction determinants in medium and low density areas while number of rooms occupied is a major determinant in high density areas.

Further studies have explained the satisfaction of students with housing units in tertiary institutions. Adeleye, Akinpelu and Azeez (2018) examined students' satisfaction with hostel accommodation in selected public tertiary institutions in Oyo State, Nigeria. The major components they used for the assessment were the environment, dwelling and management. They used descriptive statistics satisfaction indices were used in determining the degree of students' satisfaction with each of the housing components. Their findings indicated that the level of students' housing satisfaction depends on variables such as environment, dwelling and management of the housing systems. Specifically, they noted that the level of students' satisfaction with the housing environment, dwellings and management in the University of Ibadan was satisfactory and housing components in The Polytechnic, Ibadan was unsatisfactory. They also revealed that housing components can drastically influence the satisfaction of students in the hostels. Odaudu and Yahaya (2019) noted that hostels lack major facilities and are not in good condition and as such, the occupants which are students are not satisfied with the quality, condition and standard of the hostels. They noted that storage facilities were not provided in hostels and as such, students end up littering their belongings indiscriminately. Ajani *et al.,* (2018) observed that the absence of basic amenities and facilities in student residential hostels have continued to threaten housing satisfaction among students in Akure. Using relative satisfaction index, they observed that residents of hostels were largely dissatisfied with the state of the facilities and amenities in the hostels. They further noted that laundry, bathroom and toilet facilities were located distant from rooms of residence and as such, laundry facilities are not maintained regularly. In a similar study, Ifaturoti (2017) in Lagos applied cluster sampling in selecting hostels while randomly selecting occupants of hostels for data collection. He noted that owners of private hostels in Yaba made provision for security of premises, water supply and room size were adequate enough for residents. Due to the availability of the facilities, residents were mostly satisfied

with the quality of the housing facilities as there is equally ease of transportation to school, nearness to centres of religious worship and security. The implication is that privately owned hostels provided residents with better facilities than institution-owned/managed hostels.

In other related studies, Bichi *et al.,* (2018) assessed the condition and quality of hostels Kano University of Science and Technology, Wudil with a view to understanding the satisfaction of students with the housing facilities. Using questionnaire for data collection, descriptive and inferential statistics were used in carrying out analysis. Their findings showed that majority of the facilities in the hostels were in good condition. They noted that hostels had facilities such as electricity supply, water supply, efficient waste disposal systems, standby generator, security, fence, bathroom and toilets, fire-fighting equipment and bed spaces. Other facilities that were observed in the hostels were kitchenette, recreational area, drainage, laundry, privacy and writing desks which were not in very good conditions. Furthermore, Information Communication Technology (ICT) facilities were found to be in fair condition. Their study further applied Analysis of Variance (ANOVA) in carrying out inferential analysis. They established a statistical significant difference in the mean scores of condition of facilities among hostel blocks in the University.

The study of Subair and Adeniyi (2021) on the availability of hostel accommodation facilities in Obafemi Awolowo University, Ile-Ife showed increasing demand for bedspace in hostels among students. They noted that bedspaces were fairly available and were also found to be fairly accessible. They further revealed that available facilities were moderately adequate. However, the increasing demand of the hostel accommodation has led to pressure on the hostel facilities such that the hostel carrying capacities were exceeded. Having in mind that more students were being admitted in the school, it was concluded that more hostels be provided for students. However, studies have explained that students that reside in hostels usually perform better when compared to off-campus students. This is because students that are based in the campus have all their time dedicated to their academics while the later may be distracted by schedule and other happenings (Zotorvie, 2017).

The findings of the studies above revealed that hostel housing satisfaction is a derivative of several variables. Such variables include availability of facilities, amenities and quality of the housing unit. The studies also show that students are likely to be satisfied in housing units when certain facilities are installed in the housing units. For instance, majority of the studies that were presented in the review showed that the hostels were over-crowded and the facilities in the hostels were stressed due to the fact that the hostel carrying capacities were being exceeded. The studies further explained that major facilities in the housing units were lacking and laundry and bathing amenities were not in good state. Regular electricity supply and security were not guaranteed and all these affected the level of satisfaction of residents in various hostels. However, studies presented above have not reflected the case in the study area. This suggest that there is need to undertake this study with a view to filling the gap in knowledge.

Materials and Methods

Study Area

The study area is Calabar metropolis. The metropolis is located between Longitudes 8 º18` East and 8º26` East of the Greenwich meridian and Latitudes 4º50' North and 5º67' North of the Equator. It is made up of a total surface area of 159.65square kilometres. Calabar share boundaries in the North with Odukpani Local Government Area while in the West, it share boundaries with the Calabar River and in the East by the Great Kwa River. It is further bordered in the South by the Atlantic Ocean (Figure 1). The population of humans in Calabar has been rising steadily over the years. The 1991 population census results put the number of humans at 328876 (Eteng and Ajom, 2021). Current, projections indicate that over 687351 are residing in the study area. The population mix include various occupations such as civil servants, traders, farmers and artisans. Literacy level in the study area is high. This is largely traced to the early contact of the residents of the study area in time past with the colonial masters (Ojikpong *et al.,* 2016). The need to embark on tertiary learning in the study area had necessitated the setting up of tertiary schools. Notably, the study area play host to the famous University of Calabar, The University of Cross River, The College of Health Technology, School of Nursing among other tertiary institutions. The management of most of the tertiary institution have provided hostel accommodation to students for residential purposes.

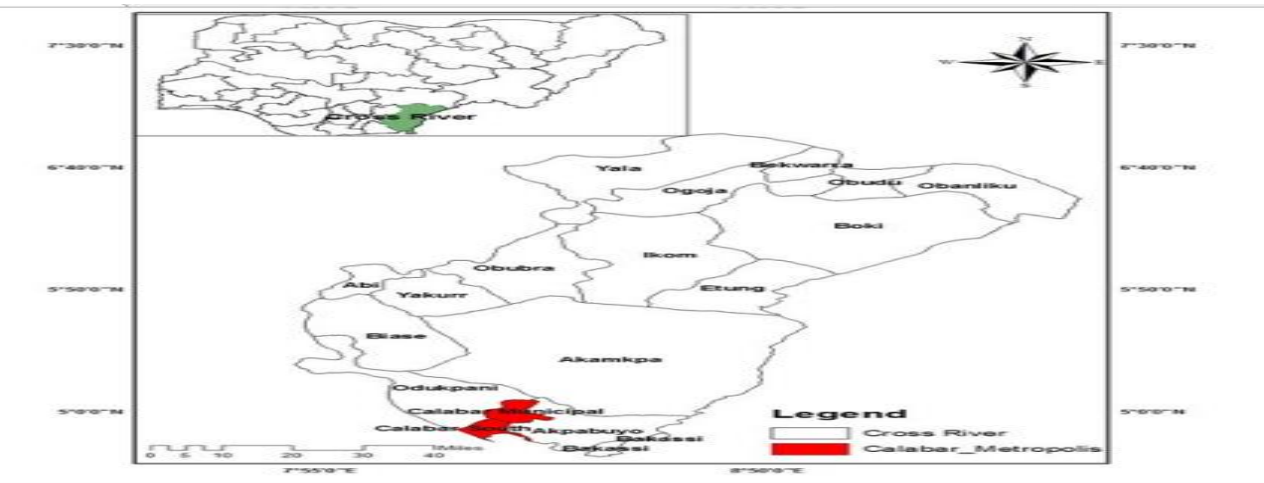

Figure 1: Map of Calabar Metropolis on the Map of Cross River State
Source: Eteng and Ajom, (2021)

Methods

The descriptive design was employed in the study. Data for the study were obtained using copies of questionnaire. The target population in the study were students who were resident in hostels in tertiary institutions in Calabar. In order to obtain data, hostel residents in three (3) tertiary institutions were purposively selected. The institutions are the University of Calabar, University of Cross River and College of Health Technology. In each of the sampled schools, 50 students who were identified to be residents in the school hostels were sampled out for questionnaire administration. Having in mind that 50 students were randomly selected in the 3 different institutions, 150 copies of questionnaire were used for data collection. The questionnaire were subdivided to male and female residents in the hostels. To this end, 75 female hostel residents were given questionnaire to complete and same was done to the male residents. Data were further analysed using Relative Satisfaction Index (RSI). RSI is mathematically represented as follows: RSI = $(5n_5+4n_4+3n_3+2n_2+1n_1)$ /5N. A five point likert scale was adopted in the study. Specifically, 5 represented very satisfied, 4 represented satisfied, 3 was fairly satisfied and 2 was dissatisfied. Furthermore, 1 represented strongly dissatisfied.

Results and Discussions

Gender and Age of Respondents

Table 1 shows the gender and age of respondents. As stated earlier, 75 copies of questionnaire were distributed to males and same to females.

Table 1: Gender and Age of Respondents

Variable	Frequency (%)
Gender	
Male	75(50)
Male	75(50)
Total	**150(100)**
Age	
Below 18	68(45.3)
18 – 20	72(48)
21 – 30	8(5.3)
31-above	2(1.4)
Total	**150(100)**

Source: Field Survey, 2022

Response therefore showed that equal percentages were observed. However, dominant occupants of hostels in tertiary institution in the study area were those below 18years old. The information in the table indicated that the older the students, the less likely they are to reside in the hostels.

Level of Housing Satisfaction in Tertiary Institutions

The information in Table 2 shows the level of satisfaction of the residents of hostels in the study area based on fifteen (15) variables. The Table showed the RSI mean for each variable. It revealed that environmental quality and walking distance to lecture halls were the most satisfactory indices to students that stay in the hostels. Residents in hostels were faced with challenges of privacy in rooms. Hence, residents in hostels were overcrowded as such, their privacy was affected. In all, the overall mean score showed that residents in the hostels were fairly satisfied with the quality, condition and facilities

in the hostels in tertiary institutions in the study area. The reason for their fair satisfaction is largely tied to the fact that the facilities provided in the hostels were not basically in good condition nor were there in a completely dilapidated state.

Table 2. Level of Housing Satisfaction in Tertiary Institutions

	Variables	Very Satisfied (%)	Satisfied (%)	Fairly Satisfied (%)	Dissatisfied (%)	Very Dissatisfied (%)	RSI
1	Environmental Quality	63(42)	38(25.3)	16(10.7)	19(12.7)	14(9.3)	3.8
2	Walking distance to lecture halls	48(32)	42(28)	16(10.6)	26(17.3)	18(12)	3.5
3	Room size	26(17.3)	46(30.7)	31(20.7)	29(19.3)	18(12)	3.2
4	Privacy in room	13(8.7)	39(26)	6(4)	41(27.3)	51(34)	1.9
5	Ventilation	11(7.3)	19(12.7)	32(21.3)	23(15.3)	65(43.3)	2.3
6	Hostel security	22(22)	28(18.7)	36(24)	32(21.3)	21(14)	3.1
7	Hostel rules	18(12)	19(12.7)	42(28)	36(24)	25(16.7)	2.9
8	Sanitation	37(24.7)	25(16.7)	35(23.3)	29(19.3)	24(16)	3.1
9	Water supply	48(32)	28(18.7)	41(27.3)	24(16)	9(6)	3.2
10	Electricity	39(32)	46(30.6)	14(9.3)	26(17.3)	25(16.7)	3.3
11	Fire-fighting equipment	22(14.7)	18(12)	24(16)	38(25.3)	48(32)	2.5
12	Bathroom/laundry facilities	21(14)	15(10)	21(14)	32(21.3)	61(40.7)	2.4
13	Recreational facilities	55(36.7)	39(26)	31(20.7)	14(9.3)	11(7.3)	3.7
13	ICT facilities	26(17.3)	33(22)	52(34.7)	16(10.7)	23(15.3)	3.2
14	Standby Generator	28(18.7)	41(27.3)	52(34.7)	18(12)	11(7.3)	3.4

RSI=45.5/15 =3

Source: Field Survey, 2022

Conclusion and Recommendations

The study appraised the level of satisfaction of students who are residents in academic hostels in tertiary institutions in Calabar. It was observed in the study that the housing units, the facilities and it quality/environment only fairly satisfied students. This imply that the level of satisfaction of the environment is not very satisfactory. This is due to the fact that residents do not have maximum access to facilities that are capable of making living within the school environment meaningful. It should be noted that the inability of students to live very satisfactorily in hostels has the potentials of affecting their academic performances as noted in earlier studies. For instance, when students are residing in unsafe and unhealthy environments, the chances of performing academically well becomes slim. Furthermore, the living condition of students which can be boosted by access to ICT facilities can drastically improve academic performances. Based on the submissions that students are not very satisfied in the hostels, it was suggested that facilities in hostels be maintained regularly. This will help in avoiding deterioration of existing facilities. As well, security and other necessities of life should be provided for students so as to improve their living condition in hostels in the study area. Finally, more halls of accommodation should be developed by school management and partners in schools within the study area so as to avoid overcrowding in rooms which have negative effect on student privacy in the hostels.

References

Adeleye, O. A, Akinpelu, O. P and Azeez, T. O (2018). Students' housing satisfaction in selected public tertiary institutions in Oyo State, Nigeria. *International Journal of Economics, Commerce and Management United Kingdom*, 4(5): 712-725

Ajayi, M., Nwosu, A and Ajani, A (2015). Students' satisfaction with hostel facilities in Federal University of

Technology, Akure, Nigeria. *European Scientific Journal*, 11(34): 402-415

Akpu, B and Sarah, D. (2015). Urban housing condition and the prevalence of celebrospinal meningitis in Badawa, Kano Metropolis, Nigeria. *Journal of Contemporary Urbanology.* 2 (1): 77-86

Bella-Omunagbe, O. C (2015). *Drivers and consequences of residents' satisfaction with off campus student housing in South-South, Nigeria.* Ph.D Thesis. Nelson Mandela Metropolitan University. 291p

Bichi, A. M., Abdu, A and Adam, A. I (2018). Assessment of quality and condition of student's hostel in Kano University of science and technology, Wudil, Kano State, Nigeria. *International Journal of Advancements in Research and Technology,* 7(12): 9-33

Etikan, I., Bala, K., Babatope, O., Yuvali, M and Bakir I. (2017). Influence of residential setting on student outcome. *Biometrics & Biostatistics International Journal,* 6(4): 409-414

Eteng, S. U and Ajom, S. K (2021). Household characteristics and water consumption among residents of Calabar, Cross River State, Nigeria. *International Journal of Scientific and Engineering Research,* 12(3): 565-571

Ifaturoti, A. S (2017). Residential satisfaction in private tertiary student housing facilities in Akoka, Lagos State, Nigeria. *Advancement in Science and Technology Research,* 3(2): 8-14

Khan, H. T (2021). Analysis of residential satisfaction: An empirical evidence from neighbouring communities of Rohingya camps in Cox's Bazar, Bangladesh. *Journal of Health,* 16(4): 5-15

Maina, J. J. (2021). An assessment of residential satisfaction in public housing using housing habitability framework system in System Framework in Gombe, Northeast Nigeria. *Malaysia Journal of Society and Space,* 17 (2): 129-142

Mansoor, U. L and Ali, M. H (2015). Academic performance of Sri Lanka Universities. International Symposium, 2015

Odaudu, U. S and Yahaya, B. F (2019). Assessment of facilities in the male hostels of University environments in Nigeria. *British Journal of Environmental Sciences,* 7(2): 21-30

Ojikpong, B. E., Agbor, E. A. and Emri, S. I. (2016). The impact of building use conversion on residential accommodation in Calabar, Cross River State, Nigeria. *International Journal of Science, Environment and Technology,* 5(3): 1445 – 1462

Onifade, V., Lawanson, T and Adewale, Y (2018). Sustainable housing satisfaction determinants in metropolitan Lagos, Nigeria. *Journal of Sustainable Development in Africa,* 20(2): 1-15

Sawyerr, P. T and Yusof, N. A (2013). Student satisfaction with hostel facilities in Nigerian Polytechnics. *Journal of Facilities Management,* 11(4): 306-322

Subair, S., Tayo, A and Omotosho, A (2021). Assessment of availability, accessibility and adequacy of hostel facilities in Nigerian Universities. *International Journal of Humanities Social Sciences and Education,* 8(7): 17-25

Ubong, B. (2007). Hostel accommodation in tertiary educational institutions in Nigeria: to be or not to be. Available at https://www.basseyubong.com/wp-content/uploads/2019/10/hostel-accommodation.pdf (Retrieved 3rd April. 2022)

UN-Habitat (2006). *National Trends in Housing – Production Practices Volume 4: Nigeria*. United Nations Habitat, Nairobi.

Zotorvie, J. S (2017). Students' accommodation and academic performance: The case of Ho Technical University, Ghana. *European Scientific Journal,* 13(13): 290-302

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RESEARCH ARTICLE

Autoregressive Distributed Lag Approach (ARDL) to Corruption and Economic Growth Nexus in Nigeria

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Abstract
The corruption in Nigeria is generating concern around the globe and among its citizens. This concern is because corruption has continued undermining the country's socio-economic development. Thus, this study empirically investigates the impact of corruption on economic growth in the Nigerian economy using annual data from 1980 to 2018. The study employed the autoregressive distributed lag (ARDL) model as its estimation technique. In this study, economic growth was proxied by gross domestic product growth rate (GDPGR), while corruption was proxied by the corruption perception index. The result revealed that corruption has a negative and significant impact on economic growth in Nigeria in the long run. This finding implies that corruption has impeded the economic development process in Nigeria within the period of this study. Thus, it was recommended that anti-corruption agencies in Nigeria, such as the Economic and Financial Crime Commission (EFCC) should be strengthened by enacting laws that will empower them to investigate, arrest and prosecute offenders.
Keywords: Corruption; Economic growth; Autoregressive distributed lag model; EFCC

Introduction

Over the years, the Nigerian government has embarked on numerous reforms for economic growth, such as privatisation, banking sector reform, anti-corruption campaigns, and the establishment of organisations like the Independent Corrupt practices commission (ICPC), Economic and Financial Crime Commission (EFCC), among others. These policies and agencies were adopted to ensure rapid economic growth and development and stem the country's rising tide of corrupt practices. Yet, the incidence of corrupt practices looms large in the country, from the military to the civilian administration.

Due to Nigeria's high level of corruption and how it affects economic growth, there is a continuing need to investigate corruption and economic growth in the nation. Nigeria's high poverty, inequality, unemployment, low standard of living, and general economic backwardness are believed to be traced to corruption. Corruption is a sickness that stunts any nation's cultural, political, and economic development and undermines the efficiency of the government's many departments. In 2005, Transparency International stated that "corruption is one of the major issues of the contemporary world, undermining the good government, profoundly distorting public policy, leading to the misallocation of resources, harming the private sector development, and especially hurting the poor." Corruption in Nigeria is one of the numerous unaddressed issues that severely impede and limit development (Ayobolu, 2006; Ubi, Eko & Ndem, 2012). It continues to be a significant long-term challenge for Nigeria's political and economic growth (Sachs, 2007). According to the International Centre for Economic Growth (1999), corruption ranges from petty to political or systematic corruption and has eaten deeply into the country's fabric. According to World Bank studies, Abiodem (2007) estimated that corruption costs over $1 trillion annually, or up to 15% of the GDP of a country like Nigeria. A cankerworm called corruption has slowed economic growth in all areas (EFCC, 2005). The difficulty in achieving rapid economic progress in Nigeria is partly due to corruption (ICPC, 2006).

Furthermore, empirical studies on the impact of corruption on economic growth showed mixed results. While some studies established a positive effect of corruption on economic growth, others found a negative impact on economic growth. For instance, studies such as Odi (2014), Yapatake, Abeid and Ngaba (2017), Odubunmi and Agbelade (2014), and Muzurura (2017), among others, have found positive impacts of corruption on economic growth. On the other hand, studies such as Tarek (2014), Rotimi and Obasaju (2013), Egunjobi (2013) and Moe and

Fredoun (2006) have established that there is a negative impact of corruption on economic growth.

Generalising how corruption affects economic growth in Nigeria is challenging due to the inconsistent findings of earlier studies, thus provoking further research. Against this background, this study wishes to investigate corruption's effect on Nigeria's economic growth. Consequently, the primary goal of this study is to examine the impact of corruption on economic growth in Nigeria. The remainder of this study is presented as follows. Section 2 presents the literature review; Section 3 presents the theoretical literature; Section 4 presents the methodology; Section 5 presents the result and discussions; Section 6 presents the discussion of findings; Section 7 gives the policy implication.

Literature Review

Concept of Corruption

Again, due to its many vices, corruption is viewed as a threat to economic growth. The economic, political, and social vices of a nation tolerating corruption are frequently under attack. According to Eigen (2001), corruption is considered a "daunting challenge to sustainable development," a hindrance to education, health care, and poverty reduction, and a significant obstacle to the Sustainable Development Goals (SDGs) of halving the number of people living in severe poverty by 2030. According to Akhabue and Ejere (2016), corruption uses public positions for personal gain. Public office is abused when a representative solicits, receives, or demands a bribe to further their interests. Private agents will also use public offices to go around government regulations and procedures for a competitive edge and financial gain. Even without the use of bribes, the exploitation of public office for personal gain is still possible through patronage and nepotism, theft of state property, or misappropriation of public funds (World Bank, 1997).

Salisu (2000) defined corruption as the misapplication of public resources to private ends, like public officials collecting bribes for issuing permits, licenses for authorising passage of goods at sea/airport, passport or visa, for contracting out work or passing laws intended to inflict artificial scarcity, granting undeserved score or grades to students after an exam, availing question papers to students before an examination. Occasionally, it could take the form of sexual or other gratifications. Transparency International (2005) described it as "the abuse of entrusted power for private gain". Similarly Khan (1996) and World Bank (1996), corruption is an action that violates the formal standards guiding the conduct of a person in a position of public authority for personal reasons like wealth, power, or status. Otite (2000) defined corruption as a perversion of integrity or state of affairs through bribery, favour or moral depravity". To establish dishonest, unfaithful, or defiling situations, at least two parties must interact to alter society's structure, procedures, or officials' behaviour. In other words, corruption is a systemic vice that manifests as favouritism, nepotism, tribalism, sectionalism, unjust enrichment, accumulating riches, abusing positions of authority, abusing power, and deriving undue advantages and benefits. Windsor and Getz (2000) defined corruption as socially impermissible deviance from some public duty or, more generally, some ideal standard of conduct.

According to Alatas (1990), there are seven categories of corruption: autogenic, defensive, extortive, investive, nepotistic, supportive, and transactive. Autogenic corruption is self-generating, and usually, only the offender is involved. What occurs in instances of insider trading would be a good example. Gaining essential knowledge that could impact a company's stock allows one to act swiftly to either buy or sell significant quantities of supplies before the information's potential effects materialise. When someone needing an essential service is forced to pay a bribe to avoid unfavourable consequences for his interests, this is referred to as defensive corruption. For instance, a person who requires a passport to travel abroad within a specific time frame may be forced to pay bribes or forfeit the trip. This personal corruption is in self-defence. Finally, extortive corruption is a person's behaviour demanding private compensation in exchange for services.

Investive corruption is the act of offering goods or services without any direct connection to a specific favour in the present but in anticipation of circumstances when the favour could be required. Nepotistic corruption refers to the inappropriate appointment of friends or family members to public office with the preferential treatment that goes beyond the recognised norms. The actions performed to safeguard or reinforce already-existing corruption typically do not include money or direct benefits. For instance, a corrupt official or regime may attempt to thwart the election or appointment of a decent person or government out of concern that they or the regime may be subject to investigation by the one in power after them. Finally, transactive corruption refers to circumstances in which two parties actively engage in corrupt behaviour for mutual benefit. For example, a dishonest business person may willingly bribe a corrupt government official to win a tender for a specific contract.

Empirical Review

Using the ordinary least squares method, Moe and Fredoun (2006) examine the impact of corruption on economic growth in Lebanon. Findings from the study indicated that corruption reduces the country's standard of living as measured by real per capita GDP and also undermines economic growth indirectly by reducing the factor input

productivity in a Cobb-Douglas production function. Further findings from the study showed that corruption increases inefficiencies in government expenditure and reduces investment and human capital productivity, negatively impacting output.

Using Granger causality and regression techniques, Odi (2014) empirically examines corruption's effect on the Nigerian economy's expansion. GDP and corruption index were used as proxies for economic growth and corruption, respectively. According to the report, Nigeria's corruption level has significantly impacted its country's economic development throughout the years. This study suggests that without zero tolerance for corruption, the economy cannot expand quickly. According to the study, efforts to combat poverty and corruption should be encouraged to increase economic growth. The Independent Corrupt Practices and Related Offences Commission (ICPC) and the Economic and Financial Crime Commission (EFCC) should also strengthen their anti-corruption initiatives.

Rotimi and Obasaju (2013) employed ordinary least squares (OLS) to analyse the link between corruption and economic growth in Nigeria. The study used the Granger causality method to measure the causal link between corruption and the gross domestic product (GDP). The findings showed that corruption hinders and has an impact on economic progress. They draw the following conclusion and recommend that public education campaigns/programs, private anti-corruption initiatives, and public anti-corruption activities be bolstered and encouraged to focus on the causes of corruption rather than its results.

Egunjobi (2013) empirically investigates the impact of corruption on economic growth in

Nigeria used annual time series data from 1980 to 2009 and employed regression analysis. Additionally, the Impulse Response Function and Granger Causality Test were run. The empirical findings show that worker-level corruption hurts capital expenditure, education spending, and production per worker directly and indirectly. The study also showed a one-sided causal relationship, with the direction of influence running from output per worker to corruption per worker. The study recommended a strategy that relies too much on activities in multiple areas instead of only one action (establishing anti-corruption agencies).

By including the corruption index in the economic growth model for Egypt, Tarek (2014) empirically studies corruption's direct and indirect effects on economic growth. The model offers a straightforward theoretical framework in which the degree of corruption and its impact on output variables, forging direct investments, government spending, openness, and political instability, are identified. The study's key finding offers empirical evidence that corruption raises inefficiencies in government spending, decreases investment, and depletes human capital, all of which negatively impact output. In addition, human capital, openness and political instability are the most crucial channel variables through which corruption is likely to reduce growth.

Odubunmi and Agbelade (2014) investigate the causality between corruption and economic growth in Nigeria. Time series (secondary) data spanning 1990 and 2010 were used in conjunction with the Granger causality test and ordinary least squares methods. The variables used were FDI inflow, the Corruption Index, the Gross Domestic Product, gross fixed capital creation, the economy's openness/globalisation, and government spending. The result revealed no significant relationship between corruption and the Economic Growth (GDP) determinant, the openness of the economy and globalisation (OEG). While corruption strongly affects economic growth and other factors, including government spending, foreign direct investment, and gross capital formation, this suggests that corruption has a positive relationship with economic growth (GDP). According to the findings of the Granger causality tests, corruption is a direct cause of FDI influx, government spending, gross capital formation, openness, and economic globalisation. Also, there is a uni-directional correlation between corruption to Economic growth (GDP) (GDP). The study's findings support preexisting claims that a nation's level of corruption is a significant factor in determining its economic growth rate. The report stated that the EFCC and ICPC, two Nigerian anti-corruption agencies, should step up their efforts and that our youth should be reoriented toward moral principles.

Using the vector autoregressive model (VAR), Yapatake, Abeid, and Ngaba (2017) examined the impact of corruption on the economic growth of Botswana covering the period 1996 to 2014. The results show that government effectiveness and export of goods and services are significant at 0.03 and 0.07, respectively and have a positive relationship with gross domestic product growth. The control of corruption is not significant but has a positive relationship with economic growth. However, the study recommended that many efforts should continue to be directed towards corruption because as the economy grows fast, there are inducements as well economy diversifications in agriculture, financial services and textiles for new growth opportunities.

Using multivariate regression and annual time series data, Musururа (2017) investigated the linkage between corruption and economic growth in Zimbabwe. The results indicate that corruption indeed impacts investment and economic growth. In addition, trade openness, foreign direct investment and inflation were also significant. The policy implications of these findings are: Zimbabwe should trim down excessive government regulation of economic activities because this facilitates bureaucratic corruption, rent-seeking, bribery, theft of public property and other forms of unrestrained opportunism. Removal of restrictions

requires political deregulation, trade openness, injecting more integrity into the procurement process, improving anti-corruption organisations, adherence to the rule of law and expanding the chances for ordinary persons to participate in governance. It is believed that excellent administration would let citizens bring their rulers to account, resulting in better accountability, transparency and economic prosperity.

Theoretical Framework

Policy-Oriented Theory of Corruption

This theory was propounded by Teveik, Albert and Charles in 1986, explaining the government's role in fighting corruption (Odi, 2014). The theory states that despite frequent corruption, government involvement in corruption has surprisingly affected the economy's growth, which needs serious investigation. Furthermore, the theory opined that the high level of corruption in developed or developing countries would impede economic growth. It was further suggested that quantifying the impact of administrative corruption on economic growth, a framework and methodology must be created if the field of administrative corruption becomes more theoretical and less descriptive.

Endogenous Growth Theory

Endogenous growth theory is linked to economists such as Arrow (1962), Romer (1986) and Lucas (1988). They believed that productivity improvements could be connected directly to a faster pace of innovation and extra investment in human capital. They emphasise the necessity for private and public sector institutions that successfully foster innovation and offer individuals and business entities the incentives to be creative. There is also a central role in accumulating knowledge as a determinant of growth. Endogenous growth theorists contend that creating a high-value-added knowledge economy is the best way to take advantage of positive externalities. The knowledge economy can help build and maintain a competitive advantage in fast-growth industries and competitive advantage within the global economy.

The endogenous growth theory's primary arguments are as follows: In the growth model, the rate of technological advancement should not be assumed to be constant. Government initiatives that increase market competition and promote product and process innovation can boost a nation's long-term economic growth. Second, there are increasing returns to scale from new capital investments. The assumption of the law of diminishing returns is questionable. Endogenous growth theorists believe in the potential for economies of scale (or increasing returns to scale) to be experienced in nearly every industry and market. Third, private sector investment in research and development is a crucial source of technical progress. Private property rights and patent protection are essential to provide appropriate and effective incentives for businesses and entrepreneurs to invest in research and development. Fourth, investment in human capital (including health, education, and training and retraining to the labour force) is crucial to long-term economic growth. Finally, government policy should encourage entrepreneurship to create new businesses and ultimately as a vital source of new jobs, investment and innovation.

However, the endogenous growth theory has been criticised on the following grounds:

One, the theory's central tenets are derived from Adam Smith and its stand on increasing returns is traced to Marx. Two, It depends on the production function and steady-state. Three, It focuses much on the role of human capital and forgets the role of institutions. The difference between physical and human capital in its different models is vague.

Methodology

The research techniques employed are based on econometric analysis, which tends to model the relationship between the dependent) and independent variables in the study. However, the Ordinary Least Square (OLS) technique was used to analyse corruption's impact on economic growth in Nigeria.

Thus, the empirical model for this can be expressed as:

GDPGR =f(COR, FDI, INFL, TOP, LITR) [1]

The econometric form of equation 3.4 can be specified as

$GDPGR_t = a_0 + a_1COR_t + a_2FDI_t + a_3INFL_t + a_4TOP_t + a_5LITR + U_t$ [2]

The logarithmic form of the model is specified as:

$Ln(GDPGR_t) = a_0 + a_1ln(COR_t) + a_2ln(FDI_t) + a_3ln(INFL_t) + a_4 ln(TOP_t) + a5ln(LIT_t) + U_t$ [3]

Where:

GDPGR = Growth rate of gross domestic product being used as a measure of economic growth

COR = Corruption

FDI = Foreign direct investment

INFL = Inflation rate

TOP= Trade openness, which is the sum of exports and imports divided by GDP (in percentage)

LITR = Literacy rate

U = Stochastic Error term

a_0 = constant term; and a_1 to a_5 = coefficients of the various explanatory variables.

It is expected that signs of the coefficients of the independent variables are: b1< 0, b2 > 0, b3 < 0, b4 > 0, b5 > < 0

Sources of Data

Annual time-series data were employed in this study on the variables from 1980 to 2018 obtained from the CBN Statistical Bulletin, CBN Annual reports, Nigerian Bureau of Statistics Bulletins and Annual Reports, Internet, Journals, Textbooks, Anti-corruption agencies reports and publications.

Result and Discussions

Unit Root Tests

Table 1: Augmented Dickey- Fuller (ADF) Test of Unit Roots

Variables	Level (first difference)	ADF Critical 1% (5%)	Order of Integration	Remark
COR	-0.725779 (-6.589377)	-3.615588 (-2.941145) -3.621023 (-2.943427)	I(1)	Integrated of order one
FDI	-3.615588 (-7.606449)	-3.574446 (-2.941145) -3.621023 (-2.943427)	I(1)	Integrated of order one
GDPGR	-4.238970	-3.615588 (-2.941145)	I(0)	Integrated of order zero
INFLA	-2.740645 (-5.883831)	-3.615588 (-2.941145) -3.621023 (-2.943427)	I(1)	Integrated of order one
LITR	-1.682835 (-4.601670)	-3.615588 (-2.941145) -3.621023 (-2.943427)	I(1)	Integrated of order one
TOP	-2.402165 (-7.126781)	-3.615588 (-2.941145) -3.621023 (-2.943427)	I(1)	Integrated of order one

Source: Authors' Computation

From Table 1, using the Augmented Dickey-Fuller (ADF) unit root test, only the GDP growth rate was stationary at level. The other variables, namely, corruption, foreign direct investment, inflation rate, trade openness and literacy rate, were stationary at first.

VAR Lag

Table 2: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1186.494	NA	2.38e+21	66.24969	66.51361	66.34180
1	-1085.915	162.0452*	6.79e+19	62.66192	64.50936*	63.30673*
2	-1051.550	43.90974	8.86e+19	62.75284	66.18374	63.95034
3	-998.9031	49.72248	5.83e+19*	61.82795*	66.84243	63.57814

Note: * indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Source: Authors' Computation

Before the regression results were estimated, the test for the selection of lag length was carried out. The aim was to determine the most significant lag length that variables would be lagged. According to Henry *et al.* (2021), several lag selection criteria can be adopted for the lag length selection. This includes; Sequential modified LR test statistics, Final prediction error, Akaike information criterion, Schwarz information criterion, and Hannan-Quinn information criterion. The result of the lag length criteria is presented in Table 2. In addition, the lag length of one (1) was selected for the study based on the Schwarz information criterion.

Cointegration Test

Table 3: Bounds Tests for the Existence of Cointegration

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	7.7190865	10%	2.75	3.79
K		5%	3.12	4.25
		2.5%	3.49	4.67
		1%	3.93	5.23

Source: Authors' Computation

The cointegration test indicates that the computed F-statistic of 7.719086 is greater than the lower and upper bounds critical values of 3.12 and 4.25, respectively, at the 5 per cent significance level. Consequently, the null hypothesis of no cointegration is rejected, meaning there is evidence of a long-run relationship among GDPGR, CORR, INFLA, FDI, LITR and TOP.

ARDL Short-Run Estimate

Table 4: Estimates of the Short Run Coefficients ARDL

Dependent Variable: Growth Rate of Gross Domestic Product

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	38.41553	5.054601	7.600111	0.0000
@TREND	0.298124	0.059610	5.001204	0.0001
D(COR)	-0.943326	1.617093	-0.583347	0.5656

D(COR(-1))	5.698490	1.782522	3.196870	0.0042
D(COR(-2))	6.323006	1.662968	3.802242	0.0010
D(INFL)	-0.153695	0.033928	-4.530039	0.0002
D(INFL(-1))	0.206067	0.032691	6.303401	0.0000
D(INFL(-2))	0.155957	0.036479	4.275289	0.0003
ECM(-1)	-0.250972	0.055289	-4.539267	0.0000
R-squared	0.744435	**Durbin-Watson stat**	2.207371	
Adjusted R-squared	0.668713			
F-statistic	9.831056			
Prob(F-statistic)	0.000003			

Source: Authors' Computation

The short-run coefficients are presented in Table 4.4. As shown, the estimates of one-year and two-year lagged values of corruption, the present value of inflation rate, the one-year lagged value of inflation rate, and the two-year lagged value of inflation rate are statistically significant at 5 per cent, respectively. This result implies that these variables seem to significantly impact Nigeria's economic growth in the short run. However, the present value of corruption was not statistically significant. Thus, the current value of corruption does not impact Nigeria's short-run economic growth.

Furthermore, the coefficient of ECM has the correct sign, which is negative and statistically significant at a 5 per cent level. The ECM result shows a slow speed of adjustment from the short to the long run of approximately 25.09 per cent. The Adjusted R-squared of 0.668713 means that the independent variables account for 66.87 per cent of the systematic change in economic growth. While the other 33.13 per cent left unexplained is attributed to other factors not captured in the model but represented by the error term. The f-statistic value of 9.831056 shows that the overall model is statistically significant. The Durbin-Watson statistics value of 2.207371 shows no autocorrelation in the estimated model.

5ARDL Long-Run Estimate

Table 5: Estimates of the Long Run Coefficients ARDL Dependent Variable: GDPGR

Variable	Coefficient	Std. Error	T-Statistic	Prob.
COR	-7.633824	3.061842	-2.493213	0.0207
FDI	3.49E-10	3.61E-10	0.966303	0.3444
INFL	-0.271438	0.052709	-5.149713	0.0000
LITR	-0.218382	0.056391	-3.872656	0.0008
TOP	8.114619	6.367861	1.274308	0.2159

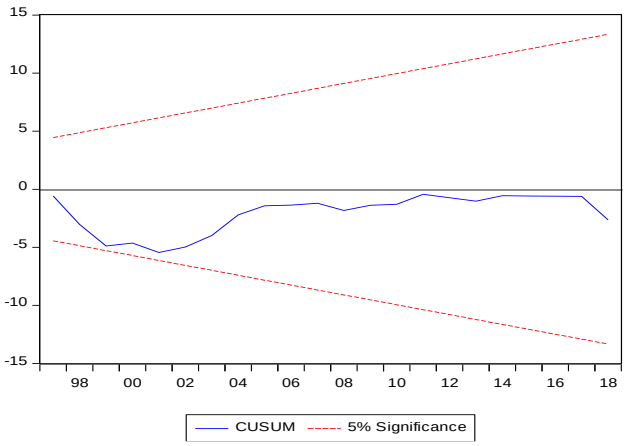
Source: Authors' Computation

The long-run coefficients are presented in Table 4.5. As shown, the estimates of corruption and inflation have the expected signs. On the other hand, foreign direct investment and trade openness are not statistically significant at the five per cent level. At the same time, corruption, inflation and literacy rate were statistically significant at a 5 per cent level. Therefore, these variables seem to impact significantly long-run economic growth in Nigeria.

Observably, corruption has a negative coefficient. Therefore, the corruption coefficient indicates that in the long run, a one per cent increase in corruption reduces economic growth by 7.63 per cent. Similarly, the inflation rate and literacy rate have negative coefficients. This result implies that a one per cent increase in inflation rate and literacy rate reduces economic growth by 0.27 and 0.22 per cents, respectively. On the other hand, foreign direct investment and trade openness all have positive coefficients indicating that a 1 per cent increase in foreign direct investment and trade openness increases economic growth by 3.49 and 8.11 per cents, respectively, in the long run.

Model Stability Test

Figure 1: Cusum Test



A diagnostic test was performed, and it can be seen that the result of the CUSUM stability test indicates that the model is stable. This stability is because both the CUSUM and CUSUM of Squares lines fall in-between the two 5% lines.

Discussion of Findings

From the findings, corruption has a negative coefficient. This outcome is due to the high level of corruption by politicians in Nigeria. Similarly, inflation rate and literacy rate have negative coefficients. The negative coefficients of

the inflation rate may be due to an increase in the general price level, which reduces people's purchasing power, leading to a low standard of living. Similarly, the negative coefficient of literacy rate could be that the country's literacy level is not high enough to promote economic growth.

On the other hand, foreign direct investment and trade openness all have positive coefficients. These outcomes may be because foreign inflow into the country is invested in strategic areas that lead to economic growth. In addition, Nigeria's trade terms have been favourable, leading to economic growth.

Conclusion and Policy Implications

This paper examined the impact of corruption on economic growth in Nigeria between 1980 and 2018. It is concluded from the findings that corruption reduces Nigeria's economic growth in both the short and the long run. Thus, the policy implication is that institutions such as the economic and financial crime commission should be strengthened to fight corrupt practices in the country. Furthermore, the government should invest more in education to enhance the population's literacy rate and control the country's prices of goods and services.

References

Abiodum, E. O. (2007). The effect of corruption and economic reforms on economic growth and development in Nigeria. *Journal of Social Sciences and Finance, 2(1): 15-25*

Alatas, H.S. (1990). Corruption: its nature causes and functions. Kuala Lumpur: S. Abdul Majeed and Co.

Ayobolu, J. (2006). EFCC, Corruption and the Due Process. Segun Toyin Dawodu, USA

Bank. New York, Oxford University PressCrimes in Nigeria," p. 39-51

EFCC (2005). Effect of Corruption on Nigeria's Economy. Nigeria EFFC Information Communication Technology Department. Abuja

Egunjobi, T.A.(2013).An econometric analysis of the impact of corruption on economic growth in Nigeria. Journal of business management and economics, 4(3); 054-065.

Henry, J. T., Ndem, B. E., Ujong, O. L., & Ihuoma, C. M. (2021). Electric power deficit and economic growth in Nigeria: a sectoral analysis. *International Journal of Energy Economics and Policy*, 11(6), 508-516. **DOI:** https://doi.org/10.32479/ijeep.11491

I.C.P.C (2006**).** Nigeria and Corruption. Independent Corrupt Practices and Other Related Offences Commission

Khan, M.H. (1996). "A Typology of Corrupt Transactions in Developing Countries" IDS Bulletin

Lucas, R. E (1988). On the mechanics of Economic Development. *Journal of Monetary Economics, 2(1); 1-9*

Moe,F. & Fredoun, Z.A.(2006). Corruption and economic growth in Lebanon. Proceedings of the Australian Agricultural and Resource Economics Society 52nd Annual Conference.

Muzurura, J.(2017).Corruption and economic growth in Zimbabwe: Unraveling the linkages. International journal of development research, 07(01), 11197-11204.

Odubunmi,A.S., & Agbelade, L.I.(2014). Corruption and economic growth in Nigeria. Journal of economics and sustainable development, 5(6), 45-56.

Romer, P. (1986). "Increasing returns and long-run growth." *Journal of Political Economy*, 94(2),1002-1037.

Rotimi, E. M., & Obasaju, B.(2013).Analysis of corruption and economic growth in Nigeria. *Afro Asian journal of social sciences*, 4(42), 1-19.

Sachs. G. (2007). "Corruption Remains Nigeria's Long Term Challenge". The Daily Independent Newspapers Tuesday, 24 April 2007

Tarek, G.(2014). Corruption and Economic Growth: Evidence from Egypt. Modern economy, 5; 1001-1009

Transparency International (2005). Corruption Index. Various series

Ubi, P. S., Eko, S. A., & Ndem, B. E. (2012). Corruption and Its Implications for Actualizing Nigeria Vision 20-2020. *Global Journal of Social Sciences*, 11(1), 41-51.

Wikipedia (2010). Wikipedia Online Dictionary. http://www.wikipedia.org/wiki/corruption-perceptions-index. Retrieved

World-Bank (1997). Helping Developing Countries Combat Corruption: The Role of the World

Yapatake, K. T.C.,Abeid, A. R., & Ngaba, M. G. M. (2017).Does control of corruption accelerate economic growth in Botswana? Global Journal of Human-Social Science, 17(16); 41-50.

Akhabue, D. A., & Ejere, O. D. (2016). Corruption in Nigeria: challenges and effect. IOSR Journal of Research & Method in Education, 6(6), 01-10. https://iosrjournals.org/iosr-jrme/papers/Vol-6%20Issue-6/Version-2/A0606020110.pdf

Odi, N. (2014). Impact of corruption on economic growth in Nigeria. *Mediterranean Journal of Social Sciences,* 5(6), 41-46. Doi:10.5901/mjss.2014.v5n6p41

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RESEARCH ARTICLE

Water, Sanitation and Hygiene Practice among Students in Secondary School, Ijebu Ode, Nigeria

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Abstract
Studies have documented that poor WaSH is accountable for several cases of diarrhea globally, resulting in millions of unnecessary deaths each year, particularly among children, and most notably in underdeveloped countries where poor knowledge and practice of WaSH have been well documented. Therefore, the work prioritizes evaluation of WaSH practice among students in secondary school in Ijebu Ode, in light of the emergence of COVID-19, which has further highlighted the essence of WaSH practice, especially in our schools. A descriptive cross-sectional approach was adopted in the conduct of the investigation, wherein data was sourced from 60 students selected through random numbers from six randomly selected secondary schools (three public and three private), representing a total student population of 360. The data collected through structured questionnaire and personal interview were computed and analyzed descriptively using Microsoft Excel and Statistical Software for Social Scientist (version 20). Findings indicated that majority of the students in Ijebu Ode have adequate knowledge (78.9%) and inadequate practice (45.6%) on WaSH, and thus, concluded that whereas the participants have adequate knowledge on WaSH, it however did not translate into an actual practice. Hence, a need for an intensive effort that will facilitate adequate WaSH practices among the school students through the availability and accessibility of appropriate WaSH resources, with school and home schedules for WaSH practice.

Keywords: Hygiene; Practice; Sanitation; Students; Wash; Water

Introduction

The right to foundational education for schoolchildren requires a safe and appropriate water supply and sanitation in schools (Mooijman 2012). For example, World Health Organization (WHO) and United Nation Children Fund (UNICEF) in 2015 reported that roughly one-third (31%) of schools worldwide do not have appropriate water supply, and many do not have proper sanitation (44%) (WHO/UNICEF, 2015). This is especially concerning in schools because children, who are considered a vulnerable group, have a increased risk of disease transmission (WHO/UNICEF, 2015; UNICEF, 1998). For example, poor WaSH have been documented to be responsible for 88 percent of diarrhea cases globally, resulting in 1.5 million unnecessary deaths each year, particularly among children (Prüss-Üstün et al., 2015), and most notably in developing countries where poor knowledge and practice have been well documented (Egbinola & Amanambu, 2015; Olukanni et al., 2014).

The attainment of Millennium Development Goals (MDG) on worldwide fundamental education, gender equality, and infant mortality, as well as the Sustainable Development Goals, and in particular Goal 6 on safe water and sanitation by 2030, have all been linked to the provision of adequate water, sanitation, and hygiene (WaSH) facilities in schools (United Nations (UN), 2015). Nonetheless, WaSH deficits continue to constitute a problem in low and middle-income countries (LMICs) around the world (United Nations Children's Fund (UNICEF), 2020), particularly in Nigeria, which is party to the UN Pronouncement of the Fundamental Right to WaSH-related activities but is among the first three LMICs with poor WaSH amenities, practices, and education awareness (WHO, 2015). It is suggested that, unsafe water supplies, as well as poor sanitation and hygiene, are thought to be responsible for about 88 percent of diarrheal illness (WHO, 2004). Other preventable diseases such as polio, hepatitis, cholera, and typhoid have spread across Africa due to a lack of clean water and a lack of knowledge about good hygiene (WHO/UNICEF, 2004).

Academic studies have demonstrated that having proper WaSH activities in schools can help students improve their knowledge, practice, and health by lowering the number of days missed in school due to menstrual periods or giving them more time to complete learning objectives (Bowen et

al. 2007; Lopez-Quintero et al. 2009; Freeman et al. 2012; Jasper et al. 2012). The reduction of diarrheal illnesses among students is estimated to result in 1.9 billion school days achieved (Hutton & Haller 2004), while lack of sanitation is blamed for 272 million school days lost each year and for the intestinal worm infestation of an estimated 400 million children (Hutton & Haller 2004; Zomerplaag & Moojiman, 2005). According to UNICEF, most of the world's schools lack clean bathrooms, drinking water, and hygiene education for students, particularly schools in rural areas, which either lack drinking water and sanitation facilities, or have infrastructure that is both insufficient in quality and quantity (UNICEF, 2004), creating high-risk situations where diseases can readily spread (WHO, 1997).
Moreover, even with acceptable facilities and resources, students' knowledge and practice of hygiene have a significant impact on their hygiene activities. Studies have demonstrated that, WaSH school-based interventions, especially those focused on adequate knowledge and practice, can help to lower the occurrence of diarrhea, communicable diseases, and other vector-borne infections, as well as infant mortality rates, all over the world (Prüss-Üstün et al., 2008). Nonetheless, despite these advantages, a lack of funds, water quality standards, accountability, and a low priority for WaSH all contribute to failure to effectively create and maintain water and hygiene services (Montgomery & Elimelech, 2007), resulting in millions of preventable illnesses and deaths each year (Montgomery & Elimelech, 2007; WHO/UNICEF, 2004). For instance, while initiatives have considerably increased the portion of the populace with access to improved water sources and appropriate sanitation around the world since 1990, they have mostly concentrated on WaSH in the household or community, rather than at the institutional level (WHO/UNICEF, 2015). As a result, there are significant gaps in WaSH access, awareness, and practice, especially in school environments (WHO/UNICEF, 2015).
However, available studies and reports from development partners' concerted efforts suggest that long-term low access to adequate WaSH services and low awareness in rural schools across the country actually provide opportunities for affordable interventions on students' knowledge and practice of WaSH. This is especially true in the face of the emergence of COVID-19, which has highlighted the importance of sanitation and hygiene, particularly in our schools (Gammon & Hunt, 2020; Olukanni et al., 2014; World Bank, 2017; Mackinnon et al., 2019). For this reason, the study prioritizes assessing the knowledge of WaSH and practice in some selected secondary schools in Ijebu Ode as a part of the Sustainable Development Goals following the 2015 Millenium Development Goal deadline. Thus, the investigation was conducted to explore the knowledge of WaSH and practice among secondary school students in Ijebu Ode, as the findings would enable policy intervention on school-based education on the promotion and implementation of WaSH practice.

Literature review

Concept of wash

Water and sanitation are critical components of a supportive atmosphere and high-quality education. In many impoverished countries, sanitary conditions in schools are appalling (Ana, 2008), and are either insufficient or unavailable, resulting in filthy latrines due to a shortage of water or a far distance from it. These conditions increase the risk of disease, which, according to Egbinola & Amanambu, (2015) is particularly prevalent among children aged 5 to 14, and can have a negative impact on cognition, growth, concentration, physical activities, and academic performance.
Moreover, despite the probable merits of adequate WaSH in educational institutions to students' health and educational performance, evidence reveals that these benefits are highly variable (Freeman et al. 2012), as they are reliant on the accessibility of vital materials and consumables including water, soap, and anal cleansing products (McMahon et al. 2011; Greene et al. 2012; Saboori et al. 2011). It has been suggested that the availability of an enabling environment, which includes government control and commitment, enough funds and a well-established supply line, defined roles and functions, monitoring, and answerability, is related to the effectiveness of sustaining these inputs (Saboori et al. 2011). More so, it has been identified that WaSH is crucial for girls' education, as inadequate water supply, sanitation, and cleanliness, which according to Lidonde (2004), have a role in the low retention of females in schools. Similarly, previous studies have demonstrated that a lack of sufficient water and sanitation facilities is a significant contributor to the significant impact on girls' enrollment and school leave in Africa's Sub-Saharan (Birdthistle et al., 2011; UNICEF/WaterAid (2013).

Impact of Poor WaSH

Reports have indicated that satisfactory WaSH in educational institutions could prevent gastrointestinal and diarrheal infections (Lopez-Quintero et al. 2009; Jasper et al. 2012). PrüssÜstün & Corvalán (2006) submitted that 94% of the causes of diarrheal diseases can be attributed to environmental influences, which include unwholesome drinking water and poor hygiene. For instance, in 2012, an estimated 502,000 and 280,000 deaths were ascribed to poor water and hygiene, respectively, out of the total 1.5 million diarrhea-related deaths reported (Prüss-Ustün et al. 2014). It has been reported that kids suffer from infectious, gastrointestinal, neurocognitive, and psychosocial problems as a result of insufficient WaSH in schools (Jasper, 2012).

Inadequate WaSH circumstances have been said to be connected to poor academic performance in children by contributing to absenteeism and reduced cognitive capacities (Alexander et al., 2013; O'Reilly et al., 2008; Bar-David et al., 2005; Bartlett, 2003; Benton & Burgess, 2009). In collaboration, Bartlett outlined the influence of filthy environments and diarrheal disease on child malnutrition as well as mental and social development, including school achievement levels, working memory, and behavioral issues (Bartlett, 2003). While a more recent literature review found ambiguous data on the subject, the standard of hygiene amenities in schools can affect girls' attendance rates, especially if they have started menstruating (Doyle, 1995; Birdthistle et al., 2011).

More so, there is some evidence to suggest that an absence of adequate WaSH may also lead to absenteeism from school (Pearson & Mcphedran, 2008), which is associated with low educational activities, interruptions in academic, a rate of school drop-out, and social development (Lamdin, 1996). WaSH and school absences are especially important for menstruating girls who require personal hygiene facilities (WHO/UNICEF, 2015; Pearson & Mcphedran, 2008; Freeman et al., 2012; Mooijman, 2012), and WaSH interventions in schools may thus help reduce gender disparities in school performance and attendance (Freeman et al., 2012).

However, some limited work has been published on the educational and health benefits of providing WaSH interventions in schools. For example, Vally et al. (2019) found that having an educational-based WaSH intervention increased students' awareness and hygiene activities, reduced absenteeism, and increased hand washing among household members in a study on the impact of school-based WaSH intervention on knowledge, practices, and diarrhea frequency in the Philippines. In contrast, Ahmed et al. (2021) found that academic attainment was significantly correlated with WaSH interventions or policies in a study conducted in Pakistan. Similarly, research has indicated that pupils at WaSH intervention schools have fewer cases of diarrhea and other sanitation-related disorders like respiratory sickness and soil-transmitted helminths (Migele et al., 2007; Freeman et al., 2012; Bieri et al., 2013; Trinies et al., 2016).

In addition, inadequate WaSH is a key concern in schools owing to the high chances for disease spread among school learners, who are considered to be a vulnerable group. However, improved knowledge and efficient hand-hygiene practices, particularly among school-children, can effectually decrease respiratory and gastrointestinal tract illnesses, the two global leading causes of childhood illness and death (Curtis & Cairncross, 2003; Mohammed et al., 2016). The above is supported by research that shows that schoolchildren who have a better understanding and practice of WaSH have fewer sick days and absenteeism, as well as higher grades (Vivas et al., 2010; Mohammed et al., 2016).

WaSH Services in LMICs

In many developing-country schools, the situation is appalling. Sanitation is either non-existent or extremely poor, making it potentially dangerous and a source of a variety of diseases. According to reports, there is a substantial shortage of WaSH activities in LMICs in Africa's Sub-Saharan, with 300 million people lacking access to potable water and 700 million lacking access to enhanced hygiene facilities. It has been projected that 71 million people will remain without access to improved water and another 130 million will fail to satisfy sanitation standards set by the MDGs (World Bank, 2017). However, despite infrastructure investment and partnership with WHO and UNICEF among LMICs in Africa's Sub-Saharan, the availability and provision of WaSH facilities in schools in rural regions has remained a key concern. According to Morgan et al., 2017 only around 22 percent of schools in rural Uganda, Zambia, Kenya, Mozambique, Rwanda and Ethiopia satisfy WHO standards for WaSH facilities and adequacy.

Similarly, differences in wealth quantiles are mostly to blame for the rural/urban divide as wealthier households and greater economic power are more common in urban regions. As a result, there is less political will in rural areas to provide basic WaSH and social infrastructure (Ojima et al., 2020; Sinharoy et al., 2019). When compared to the urban poor, rural poor households were 29 times less likely to have access to better water and 25 times less likely to have access to improved sanitation facilities, according to another study that tracked progress in WaSH in Africa's Sub-Saharan (Armah et al., 2018). In addition, when compared to other rural households, wealthier households in these areas enjoy superior WaSH services (Chasekwa et al., 2018).

WaSH in Nigeria

In Nigeria, like many other developing nations around the world, a lack of continuous, effective, and safe services is a typical occurrence, resulting in a high frequency of WaSH-related diseases, leading many people, particularly children, to become ill or even die (UNICEF, 1998). Despite efforts by government parastatals, non-governmental and non-profit organizations to improve access to safe water supply and sustainable sanitation in Nigeria's major cities, by supporting the provision of enhanced water sources and hygiene amenities in rural communities and schools, thus facilitating the realization of the national mark of 90 percent by 2015 and 100 percent by 2020 (UNICEF, 2007), huge figures of rural and urban schools and healthcare facilities remain the same. Nigeria is currently among the countries with sanitation coverage rates that are between 20% and 40% below the MDGs (Aremu, 2012; Banerjee and Morella, 2011). It has been reported that the majority of Nigerian

public secondary schools lack basic water and sanitation facilities, and hygiene teaching programs are frequently insufficient (Adam et al., 2009).

Studies have shown that the lack of basic school-WaSH services has been proven to be widespread in Nigeria, contributing considerably to youth and adolescent sanitation and hygiene practices (Egbinola & Amanambu, 2015; Wada et al., 2020; Wada & Oloruntoba, 2021). According to the World Bank, about 90% of rural Nigerians defecate in the open while 51% of rural communities lacked access to better water in 2017 (World Bank, 2017). In addition, improper sanitation and hygiene practices among Nigerian adolescents and youths have been linked to a lack of information and a negative attitude toward fundamental hygiene practise (UNICEF, 2015; Azuogu et al., 2016).

In a research to evaluate the WaSH in secondary schools in Ibadan, Nigeria, Egbinola & Amanambu (2015) found that W/C were used in just 24% of the schools, while pit toilets were utilized in 76% of the schools, with 88 percent of them being regular pit toilets and only 12% being VIP. But the study also showed that, in 77 percent of the schools, there were no wash basins, and in 88 percent of the ones that did have wash basins, there was no soap. A similar study on the WaSH program in public secondary schools in South-Western Nigeria, conducted by Olukanni in 2013, found that the majority of the schools lacked adequate WaSH practices. Of the 12 public secondary schools surveyed, only 3 (or 25%) had access to drinking water, and 40% of the schools lacked separate latrines for boys and girls. One (10%) of the schools had handwashing stations but no soap (Olukanni, 2013).

More so, An empirical study on hand-washing habits among secondary school pupils in Ebonyi, Nigeria, revealed a significant prevalence of infectious disorders including diarrhea among secondary schools, which was linked to dirty hands. The study found that washing hands with soap and water under flowing water stops the transmission of illnesses (Azuogu et al., 2016). Similarly, Ikogho & Igbudu's (2013) investigation into the accessibility and use of hand-washing facilities among primary school students in Ughelli North, Delta State, indicated that there are few facilities available, and usage is hampered by a lack of supplies and a poor maintenance culture. The study also suggested that if infectious infections were not controlled by practicing adequate handwashing, they could result in significant morbidity and mortality among schoolchildren as well as absenteeism.

However, with several Nigerians in school, prioritizing school-based intervention is critical for imparting appropriate sanitation and hygiene knowledge and practices in future generations (UNICEF, 2012).

MATERIALS AND METHODS

Study Area

The evaluation of WaSH practice among students in secondary school was conducted in Ijebu Ode, the second largest city in Ogun State, Nigeria, which is located some 60 kilometers north-west of Lagos and has an estimated population of 154,032 (National Population Commission, 2007). (See figure 1).

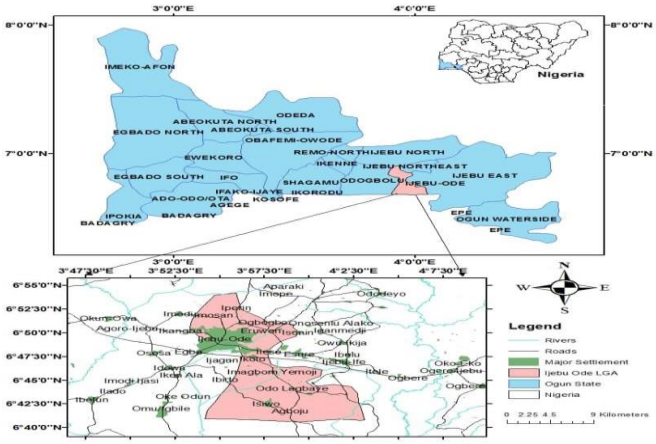

Figure 1: Ijebu Ode Spatial Map (Otto, 2022)

Sampling, Collection and Analysis of Data

The study is based on primary data collected by the researchers between January and March 2022, and which involved the use of questionnaires, interviews, and personal observation to elicit information on the respondents' knowledge and practice of WaSH. The simple random approach was used, relying on random numbers to select sample schools from the list of schools in Ijebu Ode. A total of six (three public and three private) schools were selected from the 26 and 49 public and private secondary schools, respectively. An aggregate of sixty (60) students were selected through random numbers from the six randomly selected schools (three public and three private), representing a total student population of 360. The data, which was collected via structured questionnaire and observation were computed and analyzed descriptively using Microsoft Excel and Statistical Package for Social Scientist (version 20.0), and the result presented by using frequency tables, graphs, and charts.

Classification of Levels of Knowledge and Practice of WaSH

The respondents' WaSH knowledge and practice were categorized as adequate, moderate, and low, respectively. Knowledge scores ranged from 0 to 15, and respondents who possessed adequate knowledge obtained scores of between 12 and 15 (more than 75%), moderate 8 to 11 (50–75%), while those with low knowledge had scores below 8

(less than 50%). Similarly, practice levels range from 0 to 14. Students with adequate practice obtained scores between 11 and 14 (more than 75%), and those with moderate practice had scores between 7 and 10 (50–75%), while students with low practice had scores below 7 (less than 50%). This was adapted from a previously published study (Kudavidanage et al., 2011; Wada et al., 2022).

Ethical Consideration

An official approval was gotten from the Institutional Ethics Committee, and informed consent was secured from all the secondary schools and participants with the utmost assurance of confidentiality.

Results and discussions

The present work was carried out to evaluate WaSH practice among students in secondary school, Ijebu Ode. The results of the analysis of students' knowledge of WaSH indicated that a good number of participants (78.9%) had adequate knowledge of WaSH (see table 1, figure 2). In contrast, these results are inconsistent with those of other studies that documented inadequate knowledge of WaSH (Gomathi et al., 2018; Wada et al., 2022). Our study suggests that adequate knowledge of WaSH is one of the prerequisites for effective WaSH practice, provided essential WaSH resources (water, soap, toilets, etc.) are available and accessible.

Moreover, analysis of data also reveals that 85% of the students understand that dumping of refuse in public drains can lead to flooding, while a similarly high number of them, 73.6%, are also knowledgeable that burning of waste is not a good waste disposal approach due to its environmental effects. Similar results were demonstrated by Safo-Adu & Hanson, 2019.

Further analysis indicated that 89.7% of the students knew that preserving water in a container with a tight-fitting cover is necessary to safeguard the water against potential physical or microbial contamination. These results agree with the findings of other studies that documented adequate knowledge by students on the importance of regular cleaning and proper covering of water containers (Shrestha et al., 2018; Vivas et al., 2011). Statistical results on simple treatment of water showed that 93.6% of students had an understanding that germs are killed during the boiling process of water. This result is consistent with Shrestha et al. (2018), who reported similar findings (95%) among students, but differs from the results of other research reports (Vivas et al., 2010; Vivas et al., 2011; Javaeed et al., 2018).

Additionally, approximately 69% knew that washing hands without soap after visiting the latrine is an unhygienic practice. Similarly, Dajaan et al. (2018) documented that 100% of Saudi school students understand the need for handwashing with soap and water. The present finding was further corroborated by Shrestha et al. (2018) who reported that 84% of the students had good knowledge about the importance of hand-washing after defecation, but the finding was different in comparison to others (Vivas et al., 2010; Shilunga et al., (2018).

Moreover, most students 95% recognized that hygienic and clean surroundings are needed for good health and that dirty surroundings contribute to disease spread by 92.8%. Similarly, the majority of them (93.9%) attested that it is the responsibility of people in the households to clear bushes and weeds around their houses. Regrettably, about 26.9% never knew that allowing stagnant water in their surroundings was a bad sanitation and hygiene practice. In a similar observation, Mourad et al. (2019) found that 26.5% of students believe that draining stagnant water and removing bushes surrounding the house can help avoid malaria.

Nonetheless, a majority of 87.2% of the students agree that defecating in the open spaces can adversely affect the health of the people living within the area. In a recent study, Wada et al. (2022) in a recent work suggested that 83.4% of students recognize that open defecation in school could lead to the spread of disease, as did Javaeed et al. (2018) in a similar investigation. Contrarily, Shilunga et al. (2018) in a previous report identified that over half of the students (53%) did not know whether defecation in the open spaces or bush could lead to the spread of illness.

More so, results on students' practice on WaSH showed significant evidence of inadequate WaSH practices, with less than 50% shown to have adequate WaSH practice (see table 2, figure 3). The results from our work suggest that having adequate knowledge of WaSH does not necessarily translate into actual practice, and these are evidently attributable to several factors. Notwithstanding, the current finding is consistent with recent observation by Gomathi et al. (2018) who documented that only (14%) of students in Mangalagiri reportedly have adequate practices on WaSH. The result of the current investigation was, however, contrary to (Sibiya & Gumbo (2013).

Regarding hand washing with soap and water, 73.6% of the students always wash their hands after using the latrine, whereas 65.3% wash their hands before and after meals. In support of the results, Almoslem et al. (2021) recently revealed that roughly 86% and 87% of the students washed their hands after using the toilet and before meals. In addition, recent evidence suggests that 94.4% of learners reported always washing their hands before eating and after toilet use (Shilunga et al., 2018). Sibiya & Gumbo (2013) in a previous study reported that hand washing (65%) was mostly done before eating and after visiting the toilet. Our study suggests the relevance of hand-washing as an effective preventive measure against the spread of faeco-oral and helminthic infections (such as, diarrhea, typhoid, amoebiasis, ascariasis, etc.) and the recent emergence of the

novel COVID-19 has been reported by several researchers (Curtis & Cairncross, 2003; Ruan et al., 2011; Sheren, 2012; Lee et al., 2014; Alzyood et al., 2020; Zhang et al., 2016; Gammon & Hunt, 2020). Similarly, in concordance with the results of the present study, it has been documented that the two most important moments of hand-washing are after using the toilet and before eating (UNICEF, 2020).

Additionally, on the practice of open defecation, 13.6% of the students reported always defecating in open spaces and nearby bushes, which has severe implications for public health, especially surface and ground water contamination. In agreement with the present results, previous research has reported the practice of open defecation among students (Mourad et al., 2019; Wada et al., 2022). Regarding the students' performance, 86.4% of them reported always covering their drinking water containers at home, while 70.8% always clean the drinking water containers every day. However, a significant number of the students (93.6%) knew that boiling water kills germs and therefore renders it safe, but only 34.7% reportedly boil water meant for drinking, which is the simplest method of household water treatment that renders the water safe from disease-causing organisms.

Moreover, our findings have shown that, though most of the students 78.9% had adequate knowledge of WaSH, relatively few (less than 50%) actually practiced WaSH. This is in line with the study by Aswathy (2015) and Mohd and Malik (2017), who reported that there was no relationship between respondents' knowledge and practice of hygiene. It is reasonable to assume that though the awareness of WaSH exists, the inadequacy of essential resources may negatively influence the effective practice of WaSH among the students. Although we did not collect data on the availability of resources in students' schools, the resources offered in schools are often lacking (Vivas et al., 2011; Sibiya & Gumbo, 2013; Wada et al., 2022; Jordanova et al., 2015; Shilunga et al., 2018; Weaver et al., 2016; Egbinola & Amanambu, 2015). According to a UNICEF survey done in Ethiopia, only around a third of schools have water points, and just 5% have hand washing facilities, none of which had soap (UNICEF 2009).

This current work therefore contributes to existing knowledge and practice on WaSH among students by adding to an increasing body of empirical evidence that will prove useful to donors, service providers, and policy makers in enhancing affordable but highly effective intervention programs that will significantly improve WaSH practices among students in diverse settings. This study was cross-sectional and did not capture changes in knowledge and practice of WaSH by the students, nor factors thought to influence these over time. A further study with more focus on the aforementioned is therefore suggested.

Table 1: Knowledge of WaSH

S/N	Knowledge Variables	YES		NO	
		F	%	F	%
1	Used items such as nylon bags, papers, metal scrap, cans, abandoned woods are all wastes	279	77.5	81	22.5
2	Dumping refuse in gutters, on open street and surroundings can lead to flooding	306	85.0	54	15.0
3	Burning of waste is not a good way of waste disposal and poses environmental effects	265	73.6	95	26.4
4	Burying of waste is not the right approach to dispose of refuse	286	79.4	74	20.6
5	Washing of hands without soap after using the toilet is a bad practice	250	69.4	110	30.6
6	Defecating in open spaces can affect people that are living in the area	314	87.2	46	12.8
7	The accurate way to preserve water meant for drinking is to in a container with a cover	323	89.7	37	10.3
8	Drinking water should be odorless, tasteless and colorless	329	91.4	31	8.6
9	Storing refuse in wastebin with no cover is not a good practice	303	84.2	57	15.8
10	It is the duty of people in house to cut weeds and clear bushes around their homes.	338	93.9	22	6.1
11	Presence of stationary water around the surroundings is good sanitation practice	97	26.9	263	73.1
12	Adults and kids should not be tolerable to defecate in open surroundings	323	89.7	37	10.3
13	A dirty surroundings contributes to disease spread	334	92.8	26	7.2
14	Hygienic surroundings is needed for good health	342	95.0	18	5.0
15	Boiling of water can kill the germs in it.	337	93.6	23	6.4

General Knowledge	
>75	**78.9%**
50 – 75	**20.3%**
<50	**0.8%**

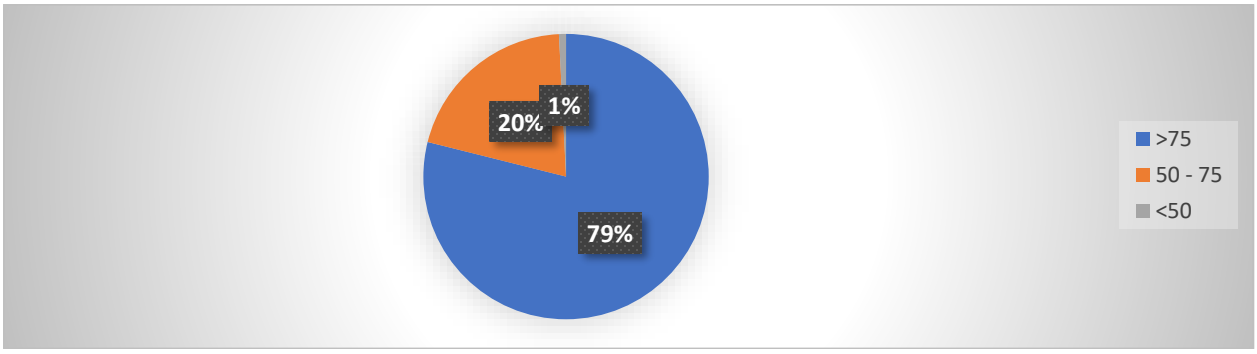

Figure 2: General Knowledge of WaSH

Table 2: Practice of WaSH

S/n	Practice Variables	Always		Sometimes		Never	
		F	**%**	**F**	**%**	**F**	**%**
1	I put waste into garbage sags and dump into gutters and on the street	79	21.9	79	21.9	202	56.1
2	When I finished using the toilet, I wash my hands with water and soap	265	73.6	91	25.3	4	1.1
3	I cover my dustbin after placing in waste	262	72.8	82	22.8	16	4.4
4	Accumulate refuse in house for one or two days before putting into the wastebin	101	28.1	125	34.7	134	37.2
5	I clear weeds and clean the household surroundings	221	61.4	127	35.3	12	3.3
6	I clean the latrine facility often	296	82.2	53	14.7	11	3.1
7	I defaecate in open spaces and nearby bushes	49	13.6	39	10.8	272	75.6
8	I allow the presence stagnant water around my surroundings	68	18.9	71	19.7	221	61.4
9	I get involved in community sanitation activities	183	50.8	137	38.1	40	11.1
10	I cover my drinking water storage at home	311	86.4	37	10.3	12	3.3
11	I wash hands properly before, and also after meals	235	65.3	83	23.1	42	11.7
12	I leave the refuse there each time I sweep	85	23.6	67	18.6	208	57.8
13	I boiled water before drinking	125	34.7	179	49.7	56	15.6
14	Clean drinking water storage everyday	255	70.8	82	22.8	23	6.4
General Practice							
>75							**45.6%**
50 – 75							**38.9%**
<50							**15.5%**

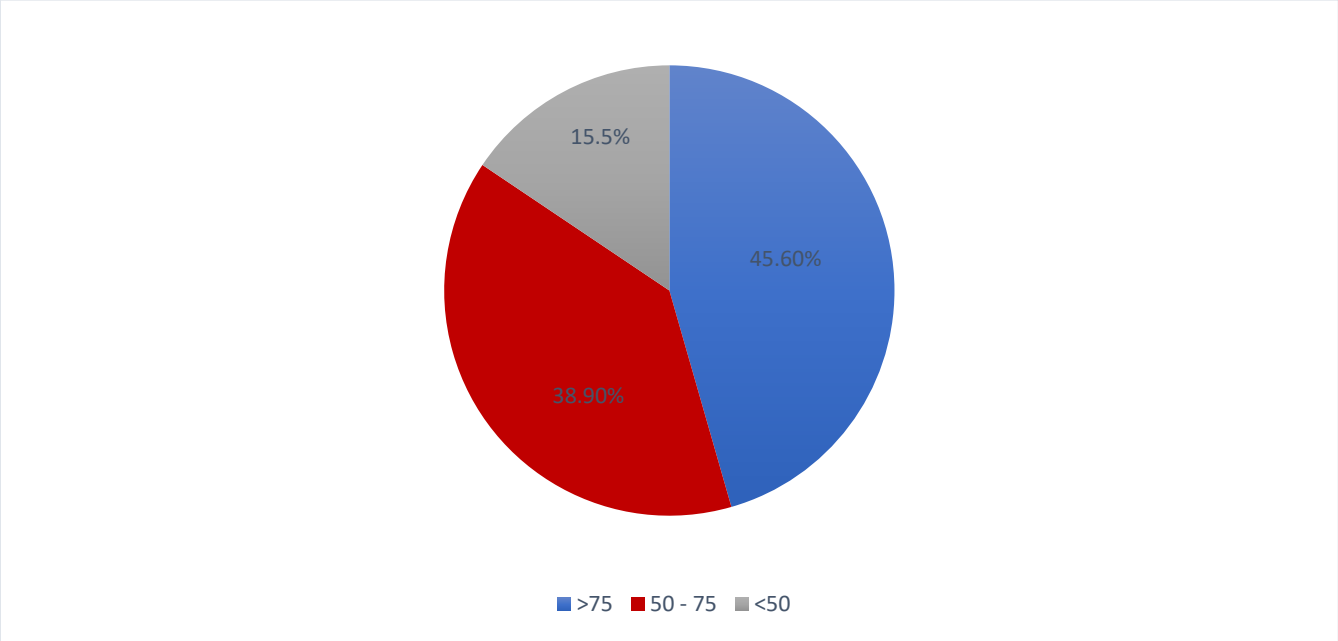

Figure 3: General Practice on WaSH

Conclusion

This study provides insights into the level of knowledge and practice of students towards WaSH, in view of its health implications, vis-a-vis potential impact on disease promotion and prevention among school students. The findings of this study indicated that most of the secondary school students in Ijebu Ode have adequate knowledge (78.9%) and inadequate practice (45.6%) on WaSH, and thus, concluded that whereas the participants have adequate knowledge on WaSH, it however did not translate into an actual practice. Hence, a need for a concentrated effort that will facilitate adequate WaSH practices among the school students through the availability and accessibility of appropriate WaSH resources, with school and home schedules for WaSH practice.

References

Adam J., J. Bartram, Y. Chartier and J. Sims. (2009). Water, Sanitation and Hygiene Standards for Schools in Low Cost Settings. World Health Organization, Geneva, Switzerland.

Ahmed, J., Wong, L. P., Chua, Y. P., Hydrie, M. Z. I., & Channa, N. (2021). Drinking water, sanitation, and hygiene (WASH) situation in primary schools of Pakistan: the impact of WASH-related interventions and policy on children school performance. *Environmental Science and Pollution Research*, 1-19.

Ana, G.R.E.E., Oloruntoba, E.O., Stridhar, M.K.C. and Adekolu, A., (2008). Water and Sanitation problems in selected schools in Ibadan, Nigeria. In: *Proceedings of the 33rd WEDC International Conference*: Ghana, Accra: Global Partnerships and Local Actions, p.12.

Alexander, K.T.; Dreibelbis, R.; Freeman, M.C.; Ojeny, B., Rheingans, R. (2013**).** Improving service

delivery of water, sanitation, and hygiene in primary schools: A cluster-randomized trial in western kenya. *J. Water Health*, *11*, 507–519.

Almoslem, M. M., Alshehri, T. A., Althumairi, A. A., Aljassim, M. T., Hassan, M. E., & Berekaa, M. M. (2021). Handwashing Knowledge, Attitudes, and Practices among Students in Eastern Province Schools, Saudi Arabia. Journal of Environmental and Public Health, 2021, 1–10. https://doi.org/10.1155/2021/6638443

Alzyood, M., Jackson, D., Aveyard, H., & Brooke, J.(2020). COVID-19 reinforces the importance of handwashing, Journal of Clinical Nursing, vol. 29, no. 15-16, pp. 2760-2761.View at: Publisher Site | Google Scholar

Aremu A. S. (2012). Assessment of Sanitation Facilities in Primary Schools within Ilorin, Nigeria. Journal of Applied Sciences in Environmental Sanitation. 7(1): 29-33.

Armah, F. A., Ekumah, B., Yawson, D. O., Odoi, J. O., Afitiri, A.-R., & Nyieku, F. E. (2018). Access to improved water and sanitation in sub-Saharan Africa in a quarter century. Heliyon, 4(11), e00931. https://doi.org/10.1016/j.heliyon.2018.e00931

Aswathy, S. K. (2015). Knowledge and practice regarding environmental sanitation and hygiene among general population. A cross sectional survey. *Global Journal for Research Analysis.* 4(11), 2277 – 8160.

Azuogu, V. C., Cajetan, I. I., Ignatius, O. N., Benedict, N. A., & Chinagorom, O. (2016). Extent of hand washing practice among secondary school students in Ebonyi State, Nigeria. International Journal of Education, Learning and Development, 4(7), 11–22. https://www.eajournals.org/wp-content/uploads/Extent-of-Hand-Washing-Practice-among-Secondary-School-Students-in-Ebonyi-State-Nigeria.pdf

Banerjee S. G. and Morella E. (2011). Africa's Water and Sanitation Infrastructure: Access, Affordability and Alternatives. The International Bank for Reconstruction and Development/ the World Bank, Washington DC, U. S. A.

Bar-David, Y.; Urkin, J.; Kozminsky, E. (2005). The effect of voluntary dehydration on cognitive functions of elementary school children. *Acta Paediatr*, *94*, 1667–1673.

Bartlett, S. (2003). Water, sanitation and urban children: The need to go beyond "improved" provision. *Environ. Urban. 15*, 57–70.

Benton, D. & Burgess, N. (2009). The effect of the consumption of water on the memory and attention of children. *Appetite*, *53*, 143–146.

Bieri, F.A.; Gray, D.J.; Williams, G.M.; Raso, G.; Li, Y.; Yuan, L.; He, Y.; Li, R.S.; Guo, F.Y.; Li, S.M.(2013). Health-Education Package to PreventWorm Infections in Chinese Schoolchildren. NEJM, 368, 1603–1612. [CrossRef] [PubMed]

Birdthistle, I., Dickson, K., Freeman, M., and Javidi, L., **(**2011). What impact does the provision of separate toilets for girls at schools have on their primary and secondary school enrolment, attendance and completion?: A systematic review of the evidence, London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Bowen, A., Ma, H., Ou, J., Billhimer,W., Long, T., Mintz, E., Hoekstra, R. M. & Luby, S. (2007). A cluster-randomized controlled trial evaluating the effect of a handwashing promotion program in Chinese primary schools. The American Journal of Tropical Medicine and Hygiene 76, 1166–1173.

Chasekwa, B., Maluccio, J. A., Ntozini, R., Moulton, L. H., Wu, F., Smith, L. E., Matare, C. R., Stoltzfus, R. J., Mbuya, M. N. N., Tielsch, J. M., Martin, S. L., Jones, A. D., Humphrey, J. H., & Fielding, K. (2018). Measuring wealth in rural communities: Lessons from the Sanitation, Hygiene, Infant Nutrition Efficacy (SHINE) trial. PLOS ONE, 13(6), e0199393. https://doi.org/10.1371/journal.pone.0199393

Curtis V, Cairncross S. (2003). Effect of washing hands with soap on diarrhea risk in the community: a systematic review. Lancet Infect Dis.3:275–81.

Dajaan, D. S., Addo, H. O., Ojo L., et al., (2018). "Hand-washing knowledge and practices among public primary schools in the Kintampo Municipality of Ghana," International Journal of Community Medicine and Public Health, vol. 5, no. 6, pp. 2205–2216. View at: Publisher Site | Google Scholar

Doyle, B.A. (1995). Increasing Education and Other Opportunities for Girls and Women with Water, Sanitation and Hygiene. Available online: http://www.ircwash.org/resources/increasing-education-and-otheropportunities- girls-and-women-water-sanitation-and-hygiene (accessed on 20 May 2022).

Egbinola, C. N., & Amanambu, A. C. (2015). Water supply, sanitation and hygiene education in secondary schools in Ibadan, Nigeria. Bulletin of Geography. https://doi.org/10.1515/bog-2015-0023

Freeman, M.C.; Greene, L.E.; Dreibelbis, R.; Saboori, S.; Muga, R.; Brumback, B.; Rheingans, R. (2012). Assessing the impact of a school-based water treatment, hygiene and sanitation programme on pupil absence in Nyanza Province, Kenya: A cluster-randomized trial. Trop. Med. Int. Health, 17, 380–391. [CrossRef] [PubMed]

Gammon, J., & Hunt, J. (2020). COVID-19 and hand hygiene: The vital importance of hand drying. British Journal of Nursing, 29(17), 1003–1006. https://doi.org/10.12968/bjon.2020.29.17.1003

Greene, L. E., Freeman, M. C., Akoko, D., Saboori, S., Moe, C. & Rheingans, R. (2012). Impact of a school-based hygiene promotion and sanitation intervention on pupil hand contamination in

Western Kenya: a cluster randomized trial. The American Journal of Tropical Medicine and Hygiene 87, 385–393. [CrossRef] [PubMed]

Gomathi, S., Samitha, P. C., Kanaka Nishanth, B., Praveen Kumar, N., & Sireesha, K. (2018). A study to assess the knowledge and practices regarding WASH among school children in selected school, Mangalagiri, Guntur district, Andhra Pradesh. International Journal Of Community Medicine And Public Health, 6(1), 253. https://doi.org/10.18203/2394-6040.ijcmph20185252

Houghton, F.; Gleeson, M.; Kelleher, K. (2003). The use of primary/national school absenteeism as a proxy retrospective child health status measure in an environmental pollution investigation. Public Health,117, 417–423. [CrossRef]

Hutton, G. & Haller, L. (2004). Evaluation of the Costs and Benefits of Water and Sanitation Improvements at

the Global Level. Water, Sanitation, and Health, Protection of the Human

Environment, World Health Organization.

Ikogho, D.E. &Igbudu, U. (2013). Availability and Utilization; of Handwashing facilities among primary school pupils in Ughelli North L.G.A; of Delta State. *Academic Research International*. 4 (5)

Jasper, C., Le, T.-T. & Bartram, J. (2012). Water and sanitation in schools: a systematic review of the health and educational outcomes. International Journal of Environmental Research and Public Health 9, 2772–2787.

Javaeed, A., Tabbasum, T., Arif, U., Ghauri, S., Khan, S., & Wajid, Z. (2018). Knowledge, Attitude and Practice of Water, Sanitation and Hygiene of Students in Azad Kashir. Rawal Medical Journal, 43(3), 536–539.

Jordanova, T., Cronk, R., Obando, W., Medina, O., Kinoshita, R., & Bartram, J. (2015). Water, Sanitation, and Hygiene in Schools in Low Socio-Economic Regions in Nicaragua: A Cross-Sectional Survey. International Journal of Environmental Research and Public Health, 12(6), 6197–6217. https://doi.org/10.3390/ijerph120606197

Kudavidanage, B. P., Gunasekara, T. D., & Hapuarachch, S. (2011). Knowledge, attitudes and practices on hand hygiene among ICU staff in Anuradhapura Teaching Hospital. *Medical Journal*; *1*, 29-40. doi: http://doi.org/10.4038/amj.v5i1.5781

Lamdin, D.J. (1996). Evidence of student attendance as an independent variable in education production functions. J. Educ. Res., 89, 155–162. [CrossRef]

Lee, M. S., Hong, S. J., and Kim, Y. T. (2015). "Hand-washing with soap and national handwashing projects in Korea: focus on the national hand-washing survey, 2006-2014,"

Epidemiology and Health, vol. 37, Article ID e2015039. View at: Publisher Site | Google Scholar

Lidonde, R., **(**2004). Scaling up school sanitation and hygiene promotion and gender concerns. In: School Sanitation and Hygiene Education Symposium. The Way Forward: Construction is Not Enough! In: *Proceedings of School Sanitation and Hygiene Education Symposium*, the Netherlands, Delft: WEDC, GWA. Available at: http://www.irc.nl/page/13136, DoA:13 December 2013.

Lopez-Quintero, C., Neumark, Y and Freeman, P., (2009). Hand washing among school children in Bogota, Colombia. In: *Health American Journal of Public Health*, Vol. 99, No. 1, pp. 94-101.

Mackinnon, E., Ayah, R., Taylor, R., Owor, M., Ssempebwa, J., Olago, D. i., Kubalako, R., Dia, T.A., Gaye, C., Campos, L.C., & Fottrell, E., (2019). 21ST Century Research in Urban WASH and Health in Sub-Sharan Africa; Methods and Outcomes in Transition. International Journal of Environmental Health Research. Vol 29, N0. 4, 457-478.

McMahon, S., Caruso, B. A., Obure, A., Okumu, F. & Rheingans, R. D. (2011) Anal cleansing practices and faecal contamination: a preliminary investigation of behaviours and conditions in schools in rural Nyanza Province, Kenya. Tropical Medicine & International Health 16, 1536–1540.

Migele, J.; Ombeki, S.; Ayalo, M.; Biggerstaff, M. (2007). Quick, R. Diarrhea prevention in a Kenyan school through the use of a simple safe water and hygiene intervention. Am. J. Trop. Med. Hyg., 76, 351–353.

Mohammed G, Nihar D, Bashayer A, Hiba I, Rasha A, Zaid A. (2016). Knowledge and Practice of Personal Hygiene among Primary School Students in Sharjah-UAE. J Health Sci.6(5):67-73.

Mohd, G., & Malik, I. (2017). Sanitation and hygiene knowledge, attitude and practices in urban setting of Bangalore: Across sectional study. *Journal of Community Medicine and Health Education.* 7(4), 540 – 545.

Montgomery, M.A.; Elimelech, M. (2007). Water and sanitation in developing countries: Including health in the equation. Environ. Sci. Technol., 41, 17–24. [CrossRef] [PubMed]

Mooijman, A. (2012). Water, Sanitation and Hygiene (WASH) in Schools. In A Companion to the Child Friendly Schools Manual; UNICEF: New York, NY, USA.

Morgan, C., Bowling, M., Bartram, J., & Lyn Kayser, G. (2017). Water, sanitation, and hygiene in schools: Status and implications of low coverage in Ethiopia, Kenya, Mozambique, Rwanda, Uganda, and Zambia. International Journal of Hygiene and Environmental Health, 220(6), 950–959. https://doi.org/10.1016/j.ijheh.2017.03.015

Mourad, K. A., Habumugisha, V., & Sule, B. F. (2019). Assessing Students' Knowledge on WASH-Related Diseases. International Journal of Environmental Research and Public Health, 16(11), 2052. https://doi.org/10.3390/ijerph16112052

National Population Commission (NPC), (2007). Population census and household data survey for Nigeria, Abuja: Federal Government of Nigeria.

Ojima, Z.W., David, B. O., Temitope, D. A., Awe, O. O.,& Iyanuoluwa, G. A. (2020). Prevalence of hypertension among rural adults and availability of management services in Abimbola Community, Ayedaade Local Government Area, Osun State, Nigeria. Journal of Hypertension and Management, 6(1), 10.23937/2474–13690/1510046.

Olukanni, D. O. (2013). Assessment Of Wash Program In Public Secondary Schools In South-Western

Nigeria. ARPN Journal of Engineering and Applied Sciences. 8(3), 7. ISSN 1819-6608

Olukanni, D.O., Ducoste, J.J. & George, T.O. (2014). Creating Water, Sanitation and Hygiene(WASH) Program Awareness in Schools; A Tool towards the Success of Community WASH program. Proceedings of EDULEARN14 Conference, 7th-19th July, 2014. Barcelona, Spain. ISBN 978-84-6170-0557-3

O'Reilly, C.E.; Freeman, M.C.; Ravani, M.; Migele, J.; Mwaki, A.; Ayalo, M.; Ombeki, S.;

Hoekstra, R.M.; Quick, R. (2008). The impact of a school-based safe water and hygiene programme on knowledge and practices of students and their parents: Nyanza Province, western Kenya, 2006. *Epidemiol. Infect.*, *136*, 80–91.

Otto, E. (2022). Evaluation of Abattoir Practices in Ijebu Ode, Nigeria. International Journal of Advances in Life Science and Technology, 6(1), 12–23. https://doi.org/10.18488/72.v6i1.3013

Pearson, J.; Mcphedran, K. (2008**).** A literature review of the non-health impacts of sanitation. Waterlines, 27, 48–61. [CrossRef]

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V., Bonjour, S., Dangour, A. D., De France, J. & Fewtrell, L. (2014). Burden of disease from inadequate water, sanitation and hygiene in low-and middle-income settings: a retrospective analysis of data from 145 countries. Tropical Medicine & International Health 19, 894–905.

Prüss-Üstün, A.; Bos, R.; Gore, F.; Bartram, J. (2008). Others Safer Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health. Available online: https://www.cabdirect.org/cabdirect/abstract/20083318172 (accessed on May 20, 2022).

Prüss-Üstün, A. & Corvalán, C. (2006). Preventing Disease Through Healthy Environments. World Health Organization, Geneva.

Ruan, F., Yang, T., Ma H. et al., (2011). "Risk factors for hand, foot, and mouth disease and herpangina and the preventive effect of hand-washing," Pediatrics, vol. 127, no. 4, pp.e898–904,. View at: Publisher Site | Google Scholar

Saboori, S., Mwaki, A., Porter, S., Okech, B., Freeman, M. & Rheingans, R. (2011). Sustaining school hand washing and water treatment programmes: lessons learned and to be learned. Waterlines 30, 298–311.

Safo-Adu, G., & Hanson, R. (2019). Practices And Knowledge About Environmental Sanitation And Hygiene Among Urban Dwellers in Gomoa East District, Ghana. European Journal of Earth And Environment, 6(1), 11.

Sheren, N. A. (2012). Knowledge and attitudes of pupils in some primary schools regarding personal hygiene in Erbil city, Kufa Journal for Nursing Sciences, vol. 2, no. 1, pp. 142–150,. View at: Google Scholar

Shilunga, A. P. K., Amukugo, H. J., & Mitonga, K. H. (2018). Knowledge, attitudes and practices of primary schools learners on sanitation and hygiene practices. International Journal Of Community Medicine And Public Health, 5(8), 3197. https://doi.org/10.18203/2394-6040.ijcmph20183051

Shrestha, M. V., Manandhar, N., & Joshi, S. K. (2018). Study on Knowledge and Practices of Water, Sanitation and Hygiene among Secondary School Students. Journal of College of Medical Sciences-Nepal, 14(3), 160–165. https://doi.org/10.3126/jcmsn.v14i3.21158

Sibiya, J., & Gumbo, J. (2013). Knowledge, Attitude and Practices (KAP) Survey on Water, Sanitation and Hygiene in Selected Schools in Vhembe District, Limpopo, South Africa. International Journal of Environmental Research and Public Health, 10(6), 2282–2295. https://doi.org/10.3390/ijerph10062282

Sinharoy, S. S., Pittluck, R., & Clasen, T. (2019). Review of drivers and barriers of water and sanitation policies for urban informal settlements in low-income and middle-income countries. Utilities Policy, 60, 100957. https://doi.org/10.1016/j.jup.2019.100957

Trinies, V.; Garn, J.; Chang, H.; Freeman, M. (2016). The Impact of a School-BasedWater, Sanitation, and Hygiene Program on Absenteeism, Diarrhea, and Respiratory Infection: A Matched–Control Trial in Mali. Am. J. Trop.Med. Hyg., 94, 1418–1425. [CrossRef] [PubMed]

UNICEF, (2004). Life skills-based hygiene education. Available at: http://www.wsp.org/Hygiene-Sanitation-Water-Toolkit/Resources/Readings/life%20skills%20Postma.pdf, DoA: 3 December 2013.

UNICEF. (2012). Raising even more clean hands: Advancing learning, health and equity through WASH in schools. https://www.unicef.org/wash/schools/files/Raising_Even_More_Clean_Hands_Web_17_October_2012.pdf. Accessed 2 May 2019.

UNICEF, (2013). Gender and water, sanitation and hygiene (WASH): Eastern and Southern Africa. Available at: http://www.unicef.org/esaro/7310_Gender_and_WASH.html, DoA: 12 November 2013.

UNICEF, (2020). Evaluation of the UNICEF supported Federal Government of Nigeria Water, Sanitation and Hygiene Programme (2014-2017). Final

Report. UK: International Organisation Development.

UNICEF/IRC. (2007). Towards Effective Programming for WASH in Schools: A manual on scaling up programmes for water, sanitation and hygiene in schools. http://www.unicef.org/wash/files/TP_48_WASH_Schools_07.pdf. Accessed 05/03/2012.

United Nations Children's Fund. (1998). A Manual on School Sanitation and Hygiene. Water, Environment and Sanitation Technical Guidelines Series No. 5. New York, NY Available at ww.irc.nl/. Accessed 15/01/2012.

United Nations Children's Fund. Water, Sanitation, and Hygiene Annual Report. [Accessed August 5, 2009]. Available at: www.unicef.org/wash

United Nations General Assembly (2015). Transforming Our World: the 2030 Agenda for Sustainable Development. United Nations, New York. https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed 2 February 2017).

Vally, H.; McMichael, C.; Doherty, C.; Li, X.; Guevarra, G.; Tobias, P. (2019). The impact of a school-based water, sanitation and hygiene intervention on knowledge, practices, and diarrhoea rates in the Philippines. Int. J. Environ. Res. Public Health, 16, 4056.[CrossRef]

Vivas A, Gelaye B, Aboset N, Kumie A, Berhane Y, Williams MA. (2010). Knowledge, Attitudes, and Practices (KAP) of Hygiene among School Children in Angolela, Ethiopia. J Prev Med Hyg.;51(2): 73–9.(https://www.ncbi.nlm.nih.gov/pubmed/21155409.

Vivas, A., Gelaye, B., Aboset, N., Kumie, A., Berhane, Y., & Williams, M. A. (2011). Knowledge, Attitudes, and Practices (KAP) of Hygiene among School Children in Angolela, Ethiopia. 16.

Wada, O. Z., & Oloruntoba, E. O. (2021). Safe reopening of schools during COVID-19: An evaluation of handwash facilities and students' hand hygiene knowledge and practices. European Journal of Environment and Public Health, 5(2), em0072. https://doi.org/10.21601/ejeph/9704

Wada, O. Z., Oloruntoba, E. O., Adejumo, M., & Aluko, O. O. (2020). Classification of sanitation services and students' sanitation practices among schools in Lagos, Nigeria. Environment and Natural Resources Research. https://doi.org/10.5539/enrr.v10n3p55

Wada, O. Z., Olawade, D. B., Oladeji, E. O., Amusa, A. O., & Oloruntoba, E. O. (2022). School water, sanitation, and hygiene inequalities: A bane of sustainable development goal six in Nigeria. Canadian Journal of Public Health. https://doi.org/10.17269/s41997-022-00633-9

Weaver, E. R. N., Agius, P. A., Veale, H., Dorning, K., Hlang, T. T., Aung, P. P., Fowkes, F. J. I., & Hellard, M. E. (2016). Water, Sanitation, and Hygiene Facilities and Hygiene Practices Associated with Diarrhea and Vomiting in Monastic Schools, Myanmar. The American Journal of Tropical Medicine and Hygiene, 95(2), 278–287. https://doi.org/10.4269/ajtmh.15-0290

WHO, (1997). Primary school physical environment and health. WHO Global School Health Initiative. In: *WHO Information Series on School Health*, Document Two. Available at: http://whqlibdoc.who.int/hq/1997/WHO_SCHOOL_97.2.pdf, DoA: 31 January 2014 .

WHO, (2004). Guidelines for drinking-water quality, 3rd ed. Recommendations, Vol. 1, Geneva:WHO.

World Bank Group. (2017). Reducing inequalities in water supply, sanitation, and hygiene in the era of the sustainable development goals: Synthesis Report of the WASH Poverty Diagnostic Initiative. https://openknowledge.worldbank.org/handle/10986/27831

World health organization (2015). Nigeria: Demographic and Economic Estimates, GLAAS, un-Water Global Analysis and Assessment of Sanitation and Drinking Water;WHO/FWC/WSH/1.579.

WHO/UNICEF. (2004). Meeting the MDG Drinking Water and Sanitation Target: A Mid-Term Assessment of Progress; Joint Monitoring Programme for Water Supply and Sanitation: Geneva, Switzerland,.

WHO/UNICEF. Progress on Sanitation and Drinking Water (2015). Update and MDG Assessment; World Health Organization: Geneva, Switzerland, 2015.

WHO/UNICEF/WSSCC, (2004). Global water supply and sanitation assessment 2000 report, Geneva: World Health Organization/United Nations Children's Fund Water Supply and Sanitation Collaborative Council.

Zhang, D., Li, Z. Zhang W. et al., (2016). Hand-washing: the main strategy for avoiding hand, foot and mouth disease, International Journal of Environmental Research and Public Health, vol. 13, no. 6, p. 610,. View at: Publisher Site | Google Scholar

Zomerplaag, J. and Mooijman, A**.,** (2005). Child-friendly hygiene and sanitation facilities in schools: indispensable to effective hygiene education. In: *Technical Paper Series*, No. 47, New York: IRC International Water and Sanitation Centre, Delft and United Nations Children's Fund, pp 1-36.

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RESEARCH ARTICLE

Pattern of Water Consumption among Students in Cross River University, Calabar Campus, Nigeria

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Abstract
The study analysed the pattern of water consumption among students in Cross River University, Calabar Campus, Nigeria. Specifically, the study examines the extent and ways water is consumed. Data for the study were obtained using interviews, observations and questionnaire.in eliciting data. A total of 300 copies of questionnaire were distributed in the residential hostels. In order to have a general impression of the situation under investigation, 150 copies of questionnaire were distributed in male hostels and same were distributed in female hostels. Data were analysed using descriptive statistics such as frequencies, simple percentages and means. A 5-point likert scale was used in understanding the level in which certain variables contribute in water consumption in the study area. The study noted that water consumption was significantly influenced by gender and age. For instance, the study highlighted that female consumed larger water quantity than males. Equally, students within the ages of 18 years and 25 years constitute larger percentage of water consumers. It was also noted that water consumption among students in the hostels was influenced by particular periods of the day. For instance, the quantity of water consumed in the morning was observed to be higher than in other periods of the day. Furthermore, bathing account for the largest quantity of water consumption while drinking constitute the least. Based on the above observations, it was suggested that the quality of water that is supplied for consumption be improved so as to allow students to drink. Finally, should be supplied at required quantity and regularly.
Keywords: Hostels; school environment; quantity/quality of water; water demand; water supply

Introduction

Water is fundamentally necessary to all living things. For instance, plants need water for growth while animals/humans need water to fasten digestion. Specifically for humans, water is needed for washing of dishes/clothes, preparation of meals, cleaning of houses, washing of cars and several other domestic duties (Ukata, Ohon, Ndik, Eze and Ibor, 2011). Therefore, water is an essential commodity to man. Water is also needed in industries (manufacturing and production) and companies etc. Even more, water is considered as one of the five major needs of man. Other necessities include air, food, light, heat and water (Utsev and Aho, 2012). Ascertaining the importance of water, Ukata et al., (2011) posited that there would come a time in the world where countries would be at war with each other not because of oil or territorial boundaries but only due to the absence of sufficient water. This is because water is not made available in sufficient quantity and in sufficient proportion in several regions of the world.

Despite the necessity of water to life and man's dependence on water for survival, water supply has continued to remain a problem mostly in developing countries of the world (Odjegba, Idowu, Ikenweiwe, Martins and Sadeeq, 2015). The problems associated with inadequate water supply in developing countries are not unconnected to poor regulatory framework, weak funding for the provision of quality water and production of water at sufficient quantity/quality. In several developing countries, policies have been made that are expected to ensure water supply without realistic evidences. For instance, the United Nations (UN) claimed that access to improved and potable water will be achieved in 2015 across developing countries. For this to be achieved, adequate water supply was captured as in the Millennium Development Goals (MDGs) (Eteng, 2021). Realistically, 2015 has come and gone yet, inaccessibility to improved and potable water has remained a recurring decimal.

Nigeria (2004) has the various policies made both locally and internationally regarding water supply. The policy which was deduced from the aftermath of several international conferences established that water is an economic commodity that needs to be supplied in required quantity and quality. Ojo (2011) has showed that most attempts channeled towards water provision in Nigeria are limited in scope to the urban residents yet, there are shortfalls in supply of water even in the urban area. Haylamicheal and Moges (2012) noted that out of 94 percent of diarrheal diseases in the world, 10 percent of the disease is linked to drinking of unsafe water, unhygienic practices and poor sanitation which are all connected to inadequate water supply.

Dakyaga, Kyessi and Msami (2018) showed that in Tanzania, water sources are unsafe and pose threats to health and wellbeing of water consumers. Haylamicheal and Moges (2010) observed that in Ethiopia, there is growing concern of water borne disease due to provision of unsafe and unhealthy water to residents. Mohammed (2014) showed that in Nigeria, the quality of water mostly in rural areas are unsafe. He showed particularly that about 29.7 percent of residents in Kano obtain water from untreated boreholes, 21 percent fetch water from untreated wells, while streams account for 8.7 percent of water. His study observed that only 20.3 percent have access to pipe borne water. Students in tertiary institutions in Nigeria are not exempted from the foregoing as access to water has remained problematic. According to the World Health Organization (WHO), each human being require at least 125 litres of water on daily basis. This suggest that students need to have access to water supply systems sufficiently. In the Nigerian educational institutions specifically in the hostels, scholars have returned different results regarding water demand/supply situation. It should be noted that consumption pattern of water is largely linked to the quantity and quality of water that is available for consumption (Eteng and Ajom, 2021; Eteng, 2021) therefore, the pattern in which students in tertiary institutions consume water can largely be attributed to the quantity/quality of water that is made available. In available studies, the pattern of consumption of water among hostel students in tertiary institutions in Nigeria have not been given adequate attention. Available studies. In Calabar, studies have shown a variation in the consumption of water among students in tertiary institutions. Eteng and Zion (2022) observed that water is demand among students is a prevalent feature. They noted that water is demand for several purposes. They approached water demand without aggregating the patterns in which water is consumed by students implying a gap in literature. Other studies, (Ugwoha and Nwike 2018; Sattar, Afridi, Afridi and Khan 2019; Eteng, Mfon and Okoi, 2022) focused on accessing water quality, water demand and water problems in tertiary institutions without giving adequate concern to the pattern of water consumption in the institutions. This suffice that there is limited knowledge regarding the pattern of water consumption in tertiary institutions specifically in the residential halls of students. Based on this premise, the paper seeks to address the foregoing so as to contribute to knowledge and equally fill the gap that is identified. Specifically, the paper appraised consumption pattern of water among students in Universities in Nigeria using Cross River University as the case study.

Literature Review

Water consumption is largely concerned with the amount of water that is reserved for use. It has to do with the water quantity that can be accessed by a particular group of people within a specific time. Holistically, consumption of water varies based on activities, lifestyles, socioeconomic attributes, countries and locations. Based on the variation on water consumption by countries, Otaki, Otaki, Sugihara, Mathurasa, Pengchai and Aramaki, (2008) noted that in Thailand, water consumption per person per day for sanitation stands at 27 litres, dish washing requires 4 litres of water while cloth washing requires 45 litres. Eja, Otu, Atu, and Edet (2011) observed that 200 litres of water is required for consumption per person on daily basis in United States of America and the required quantity of water for consumption per person is 50 litres in India. The World Health Organization suggest that individuals should consume at least 50 litres of water per person per day aggregating it to 5 litres for drinking, 20 litres for daily hygiene/sanitation, 15 litres for bathing and 10 litres for food preparation. Furthermore, the international consumption figures released by the 4th World Water Forum (2006) explained that an individual within urban areas require a minimum of 250 litres per day. When the required quantity of water is not consumed, there is every likelihood that diseases and epidemic outbreak will occur. Eteng and Ajom (2021) in their study examined the extent to which household sizes/population influence water consumption. They observed that there is water supply deficit in Calabar, Cross River State. They noted that the residents of Calabar do not have access to the required water quantity. They further noted that the inability of relevant agencies and government to provide adequate water force residents to turn to unsafe and unhealthy sources of water which have possibilities of unraveling health challenges of various magnitude.

Water consumption is equally influenced by other variables as seen in recent studies. For instance, available studies have pointed to the fact that socio-economic and demographic factors influence water consumption. Specifically, Eteng (2021) observed that factors such as gender, age, income and household size influence water consumption. Mohammed (2014) equally revealed that women consume water in larger quantity than men. Abaje, Ati and Ishaya (2009) noted a significant relationship between income of consumers and the quantity of water consumed. Similar submissions were

made by Akeju, Oladehinde and Abubakar (2018) in Ondo State and Kannayo, Ezeuilo and Maurice (2013) Eastern Nigeria. Ubugha, Okpiliya, Njoku, Itu, Ojoko and Erhabor, (2017) showed that population is a factor that equally influences water consumption

Students within hostels in tertiary institutions also demand water for various reasons. Daud and Abdullah (2020) carried out examinations of water consumption in Universities residential halls in Malaysia. They sought to understand the amount of water usage per person and the differences in water consumption among genders. In order for the authors to measure water consumption among students, they relied on information from water meter reading (in litres) which was done by observing every block of student's hostels randomly within five weeks. They further subjected the data to analysis using both descriptive and statistical hypothesis tests. They observed that the average daily water consumption of students exceed the average water demand of 250 litres per student that was provided. On the basis of gender, they noted that female students consume more water than male students. From their observations, they inferred that universities should take some initiatives to enhance student awareness on the importance of saving their daily water usage.

In a similar study in Pakistan, Sattar, Afridi, Afridi and Khan (2019) investigated the per capita demand and water consumption pattern using Ardino acquisition system and flow meter sensor. They installed the water flow sensors in the outlet pipe from water storage tank to hostels while the Ardino flow meter was used in recording the water flow for every moment. Their study showed a variation in the per capita consumption. They also noted a strong relationship between the number of student available per day and the total water consumed in liters per day. Furthermore, their study showed that there is no relationship between per capita water consumption and maximum/minimum temperature humidity wind speed. This suggest that the consumption of water among students in hostel is not significantly influenced by environmental factors. Their study also observed that water consumption among students is influenced by periods within the day. Consumption of water hit its peak in the morning hours according to the findings of the authors.

Ugwoha and Nwike (2018) analysed the quality of borehole water used in the three hostels of Choba campus of the University of Port Harcourt. Their physical parameters for carrying out the analysis were true colour, odour, turbidity, total suspended solids (TSS), temperature and total dissolved solids (TDS). Chemical parameters that they used in the assessment were pH, electrical conductivity, salinity, alkalinity, total hardness, chloride, nitrate, phosphate, biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), Iron, lead and arsenic and biological parameters. The results from their analysis showed that all physical parameters were within standards established by WHO while chemical parameters were mostly within the WHO permissible limit unless for pH (3.97 – 4.49) for all boreholes in the hostels. Biological parameters showed that water consumed in hostels was below detection. This indicate that there was no obvious biological contamination of the water. They further showed that there was no significant difference in water quality between the three hostels' boreholes. Based on their observations, they concluded that the boreholes be treated so as to ensure the reduction of acidity before consumption.

From the studies above, it is clear that water consumption in hostels and residential halls is a derivative of several factors including number of students in hostels, quantity/quality of water that is available, peak periods, activities that are carried out by the students as well as gender, income and occupancy rate in the residential halls. Notably, there is likely to be increased water consumption in hostels where students are allowed to prepare meals than in residential halls where students are deprived. Studies that are available have not consistently appraised the patterns of water consumption with particular reference to the study area. Based on this observation, the present study seeks to fill the gap in knowledge.

Methodology

The study was carried out in University of Cross River. The University is specifically located in Calabar metropolis which is the capital city of Cross River State. The University is a state-owned higher institution which came to existence in August, 2002. It was formerly known as the Polytechnics Calabar. The University has student strength of over 10,000 in Calabar Campus (Omang, 2018). Several academic courses are offered in the University at the undergraduate and postgraduate levels. The University provide hostels for it students and as such, the residents of the hostels demand water for various reasons. In spite the fact that water is consumed in varying quantities and various purposes in the hostels, available studies have not discussed it. It is on this premise that the present study was conceived.

In order to obtain data for the study, data were obtained using a combination of different methods. For instance, copies of questionnaire, interviews and observations were used in collecting data. Data were specifically obtained on the quantity of water per head that is consumed. Averages were taken in order to establish the mean quantity of water that is consumed on daily basis by students in the institution. The institution provide accommodation for both male and female students in 4 different residential halls. In order to ensure collection of data so as to have a general impression of the situation under investigation, 300 students were purposively sampled out for questionnaire administration. This consist of 150 students from male hostels and 150 students that are residents of female hostels. Data were further obtained to determine the major activities that demand water. The aggregation of water used was helpful in determining the pattern of consumption of water among

students in the institution. Data were equally obtained on the water supply situation in the study area. Such data include periods of water availability, quality of water supplied and the quantity of water that the students can access within specific periods. Furthermore, descriptive statistics were employed in carrying out analysis using frequencies and simple percentages. In order to access the variation in the consumption pattern of water based on the variables, the following model was used; (5n5+4n4+3n3+2n2+1n1) /5N (Eteng et al., 2022). A five point likert scale was adopted in the study. Specifically, 5 represent strongly agree, 4 represent agree, 3 undecided and 2 was disagree and 1 represent strongly disagree.

Discussions and Findings

Discussions and Findings

Table 1: Variation in Water Consumption

Variable	Categories	Frequency	Percentage
Gender	Male	111	37
	Female	189	63
	Total	**300**	**100**
Age	Below 18years	89	30
	18-25years	135	45
	26 and above	76	25
	Total	**300**	**100**

Source: Field Survey, 2021

The information in Table 1 explained that females consume larger quantity of water than males. This is due to the fact that female students are engaged in more activities that demand water than males. This particular observation was earlier noted in the findings of Mohammed, (2014); Daud and Abdullah (2020) and Eteng (2021). The authors showed that females consume larger water quantity being that they are mostly involved in cleaning of houses, preparation of meals among others. Daud and Abdullah (2020) equally had similar results in their study among students in Malaysian Universities. In the institutions, it was revealed that females dedicate more time to sanitation and other activities that demand water in larger quantities. Equally, the dominant age bracket of water consumers was shown to be those between the ages of 18 years and 25 years. This is due to the fact that people within this age brackets comprise the largest population of students in the institution.

Table 2: Peak Period for Water Consumption

Period	Frequency	Percentage
Morning	201	67
Afternoon	-	-
Evening	99	33
Total	**300**	**100**

Source: Field Survey, 2021

The peak period for water consumption among students in hostels was observed to be in the morning. This is due to the fact that personal hygiene, house cleaning and other chores demand water and such activities are mostly carried out in the early hours of the da. By extension, the activities process make students to demand and consume larger water quantity during the period.

The pattern of water consumption based on the specific uses in which water is consumed was ascertained using Seven (7) variables. As presented in 3, water is mostly consumed in residential halls of students in tertiary institutions for the purpose of bathing. An index score of 4.5 indicate that that bathing is the largest consumer of water in hostels. The table also noted that laundry activities account for water consumption only second to bathing. This is due to the fact that while bathing is an everyday activity that may be carried out as many times as possible by hostel residents, laundry may not necessary be an everyday activity. It is on this basis that bathing indicated greater influence on water consumption. In the table, it was also noted drinking with a score of 2.5 had the least contribution to water consumption.

Table 3: Water Consumption Pattern

S/N	Variables	Strongly agree	agree	Undecided	Disagree	Strongly disagree	Mean
1	Drinking	255	212	42	134	115	2.5
2	Bathing	960	344	27	26	0	4.5
3	Room Sanitation	505	364	156	36	38	3.7
4	Cooking/meal preparation	340	288	63	262	8	3.2
5	Personal hygiene	610	224	243	46	18	3.8
6	Laundry	945	336	15	30	7	4.4
7	Washing of dishes	440	388	186	44	31	3.6

Source: Field Survey, 2021

In other words, the amount/quantity of water that is consumed on the basis of drinking account for the least. This is not unconnected to the fact that most students avoid drinking water that is supplied in the hostels believing that it is not properly treated for consumption. As such, they buy sachet/bottle water for drinking.

Conclusion and Recommendations

The study assessed the pattern of water consumption among students of Cross River University, Calabar Campus. However, water being an essential commodity is always demanded for various purposes and the pattern of consumption is a determinant of the uses in which water is put. Therefore, it was observed in the study that demand for water among students is increasing rapidly and the increase is due to the activities that water is put. For instance, females were observed to constitute larger percentage of water consumers than males while the quantity of water consumption hit its peak in the morning hours than in other periods of the day. The study also observed that bathing/showering account for the largest percentage of water that is consumed in the hostels which is closely followed by laundry. Furthermore, the quantity of water that is set aside for drinking account for the least water quantity. The observation implied that the water that is supplied is not fit enough for drinking and as such, there is need to improve on the quality of the water. This suggest that water treatment should be given adequate attention. Having in mind that water is a necessity of utmost importance, there is need to ensure that school authorities and relevant agencies concerned with water provision remain committed to ensuring water availability and at the required quantity and quality.

References

Abaje, I. B., Ati, O. F. and Ishaya, S. (2009). Nature of potable water supply and demand in Jema'a Local Government Area of Kaduna State, Nigeria. *Research Journal of Environmental and Earth Sciences*, 1(1): 16 - 21.

Ajom, S. K and Eteng, S. U (2021). Assessment of waste scavenging activities in Calabar, Cross River State, Nigeria. International *Journal of Social Science and Human Research*, 4(11): 3141-3145

Akeju, T. J., Oladehinde, G. J and Abubakar, K. (2018). An analysis of willingness to pay (WTP) for improved water supply in Owo Local Government, Ondo State, Nigeria. *Asian Research Journal of Arts and Social Sciences*, 5(3): 1-15

Dakyaga, F., Kyessi, A. G. and Msami, J. M. (2018). Water access today and tomorrow: Domestic water sustainability under informal water supply markets in Dar es Salaam, Tanzania. *Journal of Sustainable Development*, 2(6): 120 - 140

Daud, F and Abdullah S. (2020). Water consumption trend among students in a university's residental hall. *Malaysian Journal of Social Sciences and Humanities*, 5(9): 56- 62

Eteng, S. U (2021). Analysis of water demand and supply in rural areas of Yakurr Local Government Area of Cross River State, Nigeria. MURP Dissertation. University of Uyo. 123p

Eteng, S. U and Zion, M. M (2022). Water demand among hostel residents in tertiary institutions in Calabar, Cross River State, Nigeria, *Journal of Social Sciences and Management Studies*,1(3): 167-172

Eteng, S. U. and Ajom, S. K (2021). Household characteristics and water consumption among residents of Calabar, Cross River State, Nigeria. *International Journal of Scientific and Engineering Research, 12(3): 565 – 571.* https://www.ijser.org/researchpaper/Household-Characteristics-and-Water-Consumption-among-Residents-of-Calabar-Cross-River-State-Nigeria.pdf

Eteng, S. U., Mfon, I. E and Okoi, B. J. (2022). Housing satisfaction among students in tertiary institutions in Calabar, Cross River State. Nigeria. *Journal of Environmental Science and Economics*, 1(3), 15–22

Haylamicheal, I. D. and Moges, A. (2012). Assessing the water quality of rural water supply schemes as a measure of service delivery sustainability: A case study of Wondo Genet district, Southern Ethiopia. *African Journal of Environmental Science and Technology*, 6(5): 229 – 236

Kanayo, O., Ezeuilo, U. and Maurice, O. (2013). Estimating the willingness to pay for water services in Nsukka Area of South - Eastern Nigeria using contingent valuation method: Implications doe sustainable development. Journal of Human Ecology, 41(2): 93-106

Mohammed, N. (2014). Management of domestic water by women in parts of Kano State, Nigeria. *Academic Research International*, 5(4): 360 - 369

Nigeria (2004). National water policy. Available at http://extwprlegs1.fao.org/docs/pdf/nig158231.pdf (Retrieved on 1st May, 2022)

Odjegba, E. E., Idowu, O. A., Ikenweiwe, N. B., Martins, O. and Sadeeq, A. Y. (2015). Public perception of potable water supply in Abeokuta South West, Nigeria. *Journal of Applied Science and Environmental Management*, 19(1): 5 - 9.

Ofem, B. I., Atser, J and Nwagbala, M. C (2019). Household income and water consumption rate in Uyo Urban, Nigeria. *Journal of Environmental Design*, 14(2): 66 – 74

Ojo, O. (2011). A study of rural water supply - demand situation in South West Nigeria. *Water Resource Management*, 4(145): 51 - 60.

Omang, J. E (2018). *Standards applied in the location of building projects in Cross River University of Technology - Calabar Campus.* Independent Project. Cross River University of Technology, Calabar, 53p

Otaki, Y., Otaki, M., Sugihara, H., Mathurasa, L., Pengchai, P and Aramaki, T. (2008). Microcomponents survey of residential indoor water. *Drinking Water Engineering and Science*, 2123.

Sattar, A., Afridi, A., Afridi, A and Khan I. (2019). Investigation of water consumption pattern in students hostels. *J. of Mech. Cont. and Math. Sci.,* 14(2): 427 - 445.

Ubugha, P. O., Okpiliya, F., Njoku, C. G., Itu, P. C., Ojoko, T. I. and Erhabor, F. O. (2017). People and -water: empirics of Calabar Municipality, Cross River State, Nigeria. *International Journal of Research in Environmental Science*, 3(2): 8 – 18

Ugwoha, E. and Nwike, C.O. (2018). Assessment of water quality of boreholes in choba campus hostels of University of Port Harcourt. *Uniport Journal of Engineering and Scientific Research*, 2(1): 41-47

Ukata, S. U., Ohon, E. O., Ndik, E. J., Eze, E. E and Ibor, U. U. (2011). Cost analysis of domestic water consumption in Calabar Metropolis, Cross River State. Nigeria. *Journal of Human Ecology*, 36(3): 199 – 203

Utsev, J. T. and Aho, M. I. (2012). Water shortage and health problems in Benue State – Nigeria: Impacts and prospects for solutions. *International Journal of Scientific and Technology Research,* 1(8): 77 – 85

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RESEARCH ARTICLE

The Environmental Conservation, Legal and Ethical Issues concerning Herbal Products in Nigeria

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Abstract
It has been widely reported that there have been rising cases of communicable and non-communicable disease, given the poor level of unhealthy lifestyle and disease outbreak from poor scientific laboratory management. It must be noted that Nigeria has also had its fair share of the rising cases of most infectious diseases. However, in quest of most persons affected by various communicable diseases in Nigeria, it has led finding a better solace and cures to these communicable diseases, by resulting to taking phytomedicine or herbal product. It suffices to state that the growing demand for herbal medicine in Nigeria in the cure or treatment of communicable diseases results from its natural, medicinal, and therapeutic effects. However, the increasing demand for the herbal product has resulted in indiscriminate plant harvest and various individuals not being skilled in the art of herbal medicine production to indulge in manufacturing a poor, harmful and low-quality herbal product. It must be noted that although the international community set out ethical guidelines concerning the the conservation of plant material and manufacturing of herbal medicine. It is in this regard that this study tends to examine the international legal framework concerning environmental conservation of plant material and, local legal and ethical framework concerning the production of herbal products in Nigeria.

Keywords: Environment; Conservation; Legal; Ethical; Phytomedicine; Herbal; Products; Nigeria

Introduction

It is no news that there several communicable and non-communicable diseases that are ravaging the entire global environment. Some of these communicable and non-communicable diseases include but cannot be limited to Covid19, joint, cancers, tuberculosis, sickle cell, diabetes, high blood pressure, bone disease, also sickle cell, and diabetes. It has been said that most communicable and non-communicable diseases stem from an unhealthy lifestyle, natural disasters (such as environmental pollution) (Aidonojie et al., 2020; Ukhurebor and Aidonojie, 2021) an outbreak of infection from poor laboratory management. However, it must be noted that Nigeria also has its fair share of these communicable diseases ravaging the world. This is concerning the fact that there have been reported high cases of communicable and non-communicable diseases. In the quest to eradicate and treat some of these communicable diseases, it has led to several persons or individuals relying on the herbal product (Also known as phytomedicine product) as a supplement and treatment of some of these diseases. It suffices to state that herbal medicine product is derived from various plant parts, such as; leaves, the barks of plant, roots, and tubers (Calixto, 2000; Keller, 1991). Herbal medicinal or supplement products have been proven to have numerous health benefits (Jiang, 2005; Ernst, 1998). They are very effective in treating communicable and non-communicable diseases, given the fact that it is derived from a natural substance that enhances the quality and standard of healthy living (Mahady, 2001).

It suffices to opine that given the increased rate of communicable and non-communicable diseases and the high demand for an herbal product, it has led to led to an indiscriminate plant harvesting and sporadic increase in the production and manufacturing of herbal or phytomedicine products (Gutierrez, 2014; Kaya, 2012; Riget, et al, 2016; Falkner, 2016; Ladychenko et al, 2019; Anderson and

Bows, 2008). However, the increased production of herbal products is not a major problem, but the unchecked increase of indiscriminate plant harvest and fake manufacturing of the herbal product in Nigeria.

It is concerning the above that this study tends to examine various international legal framework concerning preservation and conservation of plant. Furthermore, the study will also examine laws in Nigeria as they relate to the manufacturing of herbal or phytomedicine products. The study will x-ray and highlight some ethical guidelines and legal issues concerning herbal or phytomedicine. The study will further conclude and suggest some possible legal remedy to that will aid in regulating the production and use of herbal products in Nigeria.

International Regulatory Framework of Environmental Conservation of Herbal Materials

As a result of a change in the average weather condition, extreme events have progressively impacted biodiversity (which also include plant materials for manufacturing herbal products) globally. While the effect may differ across continental lines, the general effect is that it alters the ecosystem and exposes the plant and animal species to hazards. Due to the disproportionate annual rainfall, intense flood, and wide fire in the ecosystem, many biological plant and animal species have been forced into extinction or to relocate and secure an adaptable environment for their continuous existence. The gradual extinction of some endangered species is more worrisome, mainly in the Savannah or African region, hence the need for a regulatory framework.

Herbal products use as food supplements, and treatment of communicable and non-communicable diseases are often manufactured from plants material. Although there is no international regulatory framework directly regulating herbal product, however, it suffices to state that indirectly the Convention on International Trade in Endangered Species of Wild Fauna and Flora tends to have an effect on the manufacturing of nutraceutical and phytomedicine products. This is concerning the fact that the convention tends to place restrictions on some rare plant species by protecting and conserving them from indiscriminate harvesting and use without due permission from the appropriate body (Ukhurebor and Aidonojie, 2021; Aidonojie et al, 2020).

Article III, IV, and V of the Convention on International Trade in Endangered Species of Wild Fauna and Flora stipulate that in importing or exporting of any wild fauna and flora (which include medicinal plants) red listed in appendix I, II, and III of the convention, there must be prior approval from the exporting state upon satisfying the following conditions;

i. The scientific authority of the exporting state must have confirmed that exporting such species will not threaten and endanger the existence of the species
ii. That the species obtained was not in contravention of the exporting state laws protecting fauna and flora
iii. The exporting state is satisfied that the species obtained will be shipped in a facility that will reduce the risk of damage to the species so obtained
iv. That import permit has been obtained from the appropriate authority

Given the above, it suffices to state that if any plant that is suitable in manufacturing nutraceutical and phytomedicine products is red listed in appendix I, II, and III to the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the appropriate procedure stipulated in Article III, IV, and V of the convention must be duly complied with.

Furthermore, it suffices to state that the preservation and conservation of rear germ of agricultural produce which could also be useful in herbal production is also a major concern of the international community (Ali et al, 2020; Elmer and White, 2018). In this regard, the international community has sorted the need to, through a legal framework, ensure the development of sustainable means in ensuring the sustainable conservation and preservation of rear agricultural produce. In this regard, the International Plant Protection Convention (IPPC) came into in 1997 to address the need for international cooperation in protecting and controlling pests (which may include; animal or pathogenic agents injurious to plants, or any strain, species, or biotype of a plant) that may affect the viability of plants product and causes the spread of plants diseases or pest across borders. Furthermore, the essence of the IPPC, as stated in the preamble, is to implement recognized international principles that sort to protect humans, plants, animals, and the environment. In this regard, Article I of the IPPC provide that the signatory state should endeavor to adopt an effective action to prevent, curtail and control the spread of pests or disease of plants products and plant. Also, State takes proactive administrative, legal, and technical step in implementing the provision of the IPPC. Concerning the provision of Article of the IPPC, Article IV further places the following responsibilities on the national institute of plant protection as follows;

i. Ensuring effective surveillance of plants under cultivations to ensure they are free from pests and diseases
ii. Conducting of risk analysis as it concern pest or disease of plant products and plant
iii. Detection, report, and controlling of an outbreak pest or diseases of plants and plants products
iv. Facilitating the protection, surveillance, and maintenance of endangered areas free of pest or disease of plants

Furthermore, by Article IV(3)(b) of the IPPC, it provides thus;

Each contracting state shall facilitate and make provision, to the best of its ability as regard investigation and research in the field of plant protection

Also, article VIII(1)(C) of IPPC also provides that the contracting states to the convention shall liaise with one another to the extent of being practicable in providing biological and technical information necessary for risk analysis of pest or diseases affecting the plant. The purport of this provision suggests the fact that materials source from biological material in curing, managing, and controlling plant pests or diseases could be said to have been contemplated by Article IV(3)(b) and VIII(1)(C) of IPPC. In this, it suffices to state that the international community is well informed concerning the conservation and preservation of plant material necessary for human use such as in the production of herbal material.

Ethical Guidelines concerning Manufacturing of Herbal Product in Nigeria

At the international level, there are no international treaties or conventions concerning the regulation of herbal products. However, the world health organization, an ambit of the United Nations, had set quality standards concerning the ingredient and content of herbal or phytomedicine products. In this regard, the World Health Organisation guidelines concerning the processing of herbal products identify some ethical guidelines to be observed in the production of herbal products. Some of the guidelines are as follow;

The World Health Organisation guidelines concerning good agricultural and collection practices for medicinal plants specify some ethical and medical guidelines. The guideline provides that a good agricultural collection practice for the production of herbal drugs should accede to the following ethical and medical guidelines, which include; sorting of the medicinal plant, cleaning, and washing, leaching, cutting and sectioning, drying of the medicinal plants to reduce damage by microbial infestation except in circumstances where the medicinal plant is needed freshly, fermentation and fumigation.

Concerning good quality manufacturing practices of herbal products, the World Health Organisation came up with a guideline on Quality Manufacturing practices of Herbal or Nutraceutical and Phytomedicine products. The guideline stipulates that herbal products are prepared or manufactured from the medicinal plant if the extracted medicinal material has been subjected to the following treatment and preparation; proper extraction, purification, fractionation, distillation, fermentation, fractionation, concentration, and subjecting the said material to biological or physicochemical treatment.

It must be noted that the World Health Organisation Guidelines on Quality Production of Herbal Dosage Forms further ensure that for there to be a good production of herbal dosage forms, it must aim at ensuring that medicinal plant material is suitable for the production of the final product and dosage forms of the herbal products.

The above serves as a guild line and ethical issues as stipulated by the World Health Organisation concerning the production of herbal medicine. However, the primary regulatory frame was left for countries where the activities are taking place to intervene and regulate the same in accordance with their laws.

Regulation of Nutraceutical and Phytomedicine under the Nigeria Law

Although the words herbal or phytomedicine are not expressly mentioned in any of the laws in Nigeria, however, they are often grouped into drugs which could be pharmaceutical and herbal drugs or supplements. This is concerning the fact that section 31, which is the interpretative section of the National Agency for Food and Drug Administration and Control Act, describe drug to include “any substance of vegetable, animal or any preparation or admixture that is manufactured to diagnose, mitigate, treat or prevent disease, abnormal physical state, and disorder state in man or animal. Given this description of what constitute drugs, to a large extent or by interpretation, it includes herbal or phytomedicine product, given the fact that they are mainly extracted from a plant for the purpose of serving as a supplement and medicine in the treatment of communicable and non-communicable disease.

Given the above, it suffices that in Nigeria, there are several laws that could serve as a means of regulating the production and use of herbal products, and they are examined as follows;

Nigeria Drug Products Advertisement Regulation

However, it must be noted that Article 2 of the Nigeria Drug Products Advertisement Regulation under the schedule to the Subsidiary Legislation of the National Agency for Food and Drug Administration and Control Act stipulate that before any drug (which may include herbal or phytomedicine product) can be advertised in Nigeria, there must be the issuance of pre-clearance and approval by the National Agency for Food and Drug Administration and Control. Article 1 of the regulation stipulated that whether a product is locally manufactured or imported into Nigeria, pre-clearance, and approval by the agency is a prerequisite for any advertisement and selling of such medicinal product.

It must be noted that Articles 11 and 16 of the Nigeria Drug Products Advertisement Regulation required that in

advertising any drugs product (may likely include herbal product) for sale, appropriate caution with regard to the usage of the product must be stated. Furthermore, it stipulates that a proper advertisement or labeling of a product should effectively and reasonably provide vital information concerning the safety, effectiveness, contra-indication, and side effect that may be adverse when consumed. To ensure effective compliance, Article 14 of the Nigeria Drug Products Advertisement regulation further require an individual or owner of a drug product (which is likely to include herbal product) to ensure their product has a proper prescription contained in a label which shall include the following information;

i. The name of the products and their brand name
ii. The content or ingredient of the product
iii. Indicating what the product is used for
iv. A proper description of the dosage
v. Duration of use of the product
vi. Mode of storage
vii. Manufacturing date
viii. Expiration date
ix. Adequate caution and warning concerning the product side effect

However, despite the above provision of Article 14 of the Nigeria Drug Product Advertisement Regulation, Article 12 of the regulation further caution manufacturers or owners of a product not to state in any advertisement or imply that their product is "safe," "possess special status" or "guarantee its efficacy." However, any claims as to the effectiveness, less toxic and safety of a product by a producer must be adequately substantiated. In substantiating any claims of less toxic nature and safety of a product, section 18 and 19 of the Nigeria Drug Product Advertisement Regulation require the owner or producer of a drug product (which include herbal products) to substantiate their claims by furnishing an accurate and proper interpretation of their research findings and any claims from scientific literature substantiating the safety, efficacy and adverse effect of the product.

Concerning the above provision articles 11, 12, 14, 16, 18, and 19 of the regulation, it must be noted that the regulation is required to adhere strictly. This is concerning the fact that, by Article 12 of the regulation, it is considered as an offence if producers provide misleading or false information concerning the efficacy, safety, and effectiveness of their product, or unsubstantiated claim or an impression that their product is safer and better than other related product. This position of the law has been aptly recognized in the case of George Abi V. Central Bank of Nigeria & Ors (2012) 3 NWLR (Pt. 1286), 1 at 38 and 48, the court although, it is the duty of a medical officer to inform a patient concerning the side effect of drugs or supplement and the risk therein. However, the court further stated that if a medical officer has exacted his professional knowledge skill and follows the prescription of the product, the medical officer will not be held liable for any resultant side effect. The purport of this decision of the court is that in this circumstance, it is the owner of the product that will be held liable for not adequately stating possible side effects the product may cause to an individual.

Counterfeit and Fake Drugs and Unwholesome Processed Foods (Miscellaneous Provisions) Act

This Act regulates any fake or counterfeit drugs or food that has not been properly processed. In this regard, it suffices to state that, given the provision of Article 11, 12, 14, 16, 18, and 19 of the Nigeria Drug Product Advertisement Regulation, a drug (which include an herbal product or phytomedicine product) is considered fake, where there is misleading or false information concerning the safety and effectiveness of the product. This is concerning the fact that section 12 of the Counterfeit and Fake Drugs and Unwholesome Processed Foods (Miscellaneous Provisions) Act defined "fake drug" to include;

1. Any drug product container which is so designed to mislead the general public
2. A product that does not specify the following

i. An appropriate direction of the product use,
ii. Sufficient warning of the product use
iii. Method of use
iv. Dosage of the product to be taken
v. Production and expiry date

3. A product that is not registered in accordance with the drugs, food, and other related product Act in Nigeria

Concerning the above-cited provisions of section 12 of the Counterfeit and Fake Drugs and Unwholesome Processed Foods (Miscellaneous Provisions) Act, a product that possesses or fall any of the condition stated therein is considered fake. Section 1 of the Fake Drugs Act prohibits the manufacturing, importation, possession, or sell, aid, and abets anyone in the manufacturing, importation, and selling of any product which falls within the specification of the Act. Section 3 and 8 of the Fake Drugs Act empower the state task force to confiscate the said fake drugs and materials used in the production of the fake products. Furthermore, the section also imposed penalties of N 500,000 or imprisonment not less than five years if anyone is found guilty.

National Drug Formulary and Essential Drugs List Act

It suffices to state that in Nigeria, the production or importation of drugs must contain or fall within the range of the list of drugs permitted by law. This is concerning the fact that section 1 of the National Drug Formulary and Essential Drugs List Act specifically stipulates the list of formulary and essential drugs permissible for production

and importation in Nigeria. And by section 2 of the Act, anyone found wanting of production, selling, advertising, and importing any drugs (which may likely include herbal products) not contained in the list has committed an offence. Although section 3 of the Act further provide if an individual is interested in manufacturing or importing any drugs not contained in the list provided for in the first schedule to the Act, such individual must apply to the minister In charge of health matter for approval upon satisfying the minister on the following ground;

i. That the product made or imported for treating uncommon disease (just like the ebola and Covid19 cases)
ii. That the common drug or product listed in the first schedule to National Drug Formulary and Essential Drugs List Act is not responsive enough to treat the disease
iii. That the drug is of great relevance and more responsive to those listed in the schedule to the Act

If the above condition has been satisfied, the minister of health may grant approval for the production or importation of such product. However, it seems by section 7 of the Act, an individual or firm may recommend to the National Drug Formulary and Essential Drug List Review Committee any product or formulation considered relevant treating communicable and non-communicable disease but not included in the list.

Also, in Nigeria, there are several health agencies responsible for the administration of the various laws that regulate drugs, foods, and supplement products, some of which are;

1. The National Agency for Drug Administration and Control Agency
2. The above laws are National Drug Formulary and Essential Drug List Review Committee
3. National Drug Law Enforcement Agency
4. National Primary Health Care Development Agency
5. Consumer Protection Council

The above agencies are saddled with the responsibility of regulating and implementing the various laws that regulate the importation, manufacturing, sales, or distribution of drugs, food, and supplement products (Olomojobi, 2019; Mckenzie et al., 2014). The agencies must also be required to conduct scientific tests on the product and the standard of facilities and factories in ascertaining if it is of quality standard and safe for the public to consume (Obioha et al., 2010; Omonona, 2015).

Legal Issues or Challenges Concerning Nutraceutical and Phytomedicine Products

Herbal products have been proven to be very effective as a supplement and treatment of communicable and non-communicable diseases. However, despite the numerous benefit of herbal product, there are still some legal issues or challenges inherent in the regulatory framework, and they are considered as follows;

1.Lack Direct National Legislation Regulating Herbal Product

Although, it may be argued that, given section 3 of the Act that it create a lily way for the importation or production of the herbal or phytomedicine products, however, it suffices to opine that given the condition stated therein before a minister could grant approval for the production or importation of drugs did not mention herbal drugs, but rather pharmaceutical drugs. Furthermore, it suffices to state that a perusal of the first schedule to the Nigeria National Drug Formulary and Essential Drugs List Act reveals that herbal or phytomedicine is not directly mentioned in the Act.

In this regard, the lack of a regulatory framework indirectly regulating herbal or phytomedicine products within Nigerians may lead to quack and fake manufacturing of an herbal medicinal product.

2.National Legislation Restriction

Although, a perusal of the first schedule to the Nigeria National Drug Formulary and Essential Drugs List Act reveals that herbal or phytomedicine is not directly mentioned in the Act. Although, it may be argued by some individual that, given section 3 of the Act, it create a lily way for the importation or production of herbal products. However, it suffices to opine that even if reliance is placed on the various Nigeria legal framework as being relevant in regulating the herbal medicinal product, given the condition stated therein before a minister could grant approval for the production or importation of herbal or phytomedicine, this, in essence, could be very bureaucratic that may result to a bottleneck that may discourage potent and qualify manufacturer of herbal product.

3.The multiplicity of National Regulatory Legal Framework

There are several national regulatory frameworks (international guidelines, monographs, and national laws regulating the manufacturing and use of drugs which by implication could also be argued that it refers to herbal or phytomedicine products) concerning herbal or phytomedicine products. Given the multiplicity of regulatory frameworks existing side by side, it could render the whole process of regulating the manufacturing and use of herbal or phytomedicine products very complex. Furthermore, it may result in a conflict of laws; thus, a manufacturer may be faced and confused with the task of identifying the international and national regulatory framework that may be applicable in guiding the whole

process of manufacturing herbal or phytomedicine products. Furthermore, it suffices to state majority of the laws that are deemed to indirectly regulate the production of herbal could easily lead to a bureaucratic process of enforcement and compliance, given the multiplicity of the supposed regulatory framework. In essence, it could lead to the production of quack or fake herbal medicinal products.

4. The tort of Negligence (Doctrinal of Res Ipsa Loquitur)

In a civil proceeding, it is a principle of law that an individual who asserts must prove with his case relying on convincing evidence. In this regard, there are certain instances where a herbal or phytomedicine product which may have been term safe and effective, but an individual could trace the harm or damage suffered resulting from consuming or taking a herbal or phytomedicine product, such individual could rely on the doctrine of res ipsa loquitur which means "the fact speaks for itself." In this regard, in relying on res ipsa loquitur doctrine against the owner of a product that an individual links the harm suffered, the owner of the product is oftentimes legally amputated. In the case of George Abi V. Central Bank of Nigeria & Ors (2012) 3 NWLR (Pt. 1286), 1 at 32-33, the court stated that the doctrine of res ipsa loquitur is a rule in Tort law that requires an individual to prove a case without having to prove that the owner of a product negligence specific act or omission resulted to damage or harm he/she suffered. What such individuals need to show to the court is the result of the damage or harm suffered.

Given the above, the doctrine of res ipsa loquitur is a principle that majorly legally works against the owner of herbal or phytomedicine products no matter how careful a producer may envisage in producing their products. This concerns the fact that all the complainant needs to show to the court in claiming damage is the surrounding circumstances that led to damage or harm suffered in consuming the herbal or phytomedicine products.

Conclusion/Recommendation

In this study, it has been highlighted that there has been a high rate of communicable and non-communicable diseases ravaging the global environment. That Nigeria has also had its fair share of the communicable and non-communicable diseases affecting the international community. It was also stated that in the quest of finding an effective treatment concerning communicable and non-communicable diseases, it has led to the reliance on herbal products, given their natural potency and therapeutic effect in the treatment of communicable and non-communicable diseases.

However, it was also established that given the relevance of the herbal product, it has degenerated to a multiplicity of several unchecked and unregulated manufacture herbal products. Although it was identified that the World Health Organisation has set out ethical guild line concerning the processing and production of herbal products, however, countries are given the regulatory power to regulate the production of the herbal product within their territory.

It was also identified that, though there is several legislation concerning the regulation of pharmaceutical drugs, however, there seems to be legislative silence or missing link concerning the herbal product. This concerns the fact that there was no express provision that mentioned herbal products in the various Nigeria regulatory framework. In this regard, it has further resulted in some ethical and legal issues in the production of herbal products.

In this regard, it, therefore, recommended that given the relevance and importance of herbal products;

i. That there is a need for Nigeria to adopt a unified and effective legal framework that will adequately address scientific and legal issues as it concerns the whole process involved in the production of herbal products.
ii. Given the above, there is a need for the Nigerian law to be reviewed to adequately capture the regulations of the processing and production of herbal products
iii. Furthermore, it is recommended that there is need to set up an effective regulatory body that will be solely charged with the responsibility of administrative regulation of the ethical processing and production of herbal products

References

Aidonojie P. A., Anani O. A., Agbale O. P., Olomukoro J. O., Adetunji O. C., 2020. Environmental Law in Nigeria: A Review on its Antecedence, Application, Judicial Unfairness and Prospects. Archive of Science & Technology 1(2) 212 - 221

Ernst, E., (1998). Harmless herbs? A review of the recent literature. America Journal of Medicine. 104, 170–178.

Jiang, W.-Y., (2005). Therapeutic wisdom in traditional Chinese medicine: a perspective from modern science. Trends Pharmacol. Science 26(11), 558–563.

Kayne, S.B., (2010) Traditional Medicine: a Global Perspective. Pharmaceutical Press,
London.

Mahady, G.B., (2001) Global harmonization of herbal health claims. Journal of Nutrition, 131(3), 1120S–1123S.

Vanherweghem, L.J., (1998) Misuse of herbal remedies: the case of an outbreak of terminal renal failure in Belgium (Chinese herbs nephropathy). Journal of Alternative Complement Medicine 4(1), 9–13.

Angell, M. & Kassirer, J.P. (1998) Alternative medicine — The risks of untested and irregular remedies. New England Journal of Medicine, 339(12), 839–841

Awang, D.V.C. (1997) Quality control and good manufacturing practices: Safety and efficacy of commercial herbals. Food Drug Law Journal, **52**, 341–344

Calixto, J.B. (2000) Efficacy, safety, quality control, marketing and regulatory guidelines for herbal medicines (phytotherapeutic agents). Brazilian Journal of medical & biological Research., 33(2), 179–189

Keller, K. (1991) Legal requirements for the use of phytopharmaceutical drugs in the Federal Republic of Germany. Journal of Ethnopharmacol., 32 (3), 225–229

World Health Organisation guidelines on good agricultural and collection practices (GACP) for medicinal plants, Geneva; 2003.

World Health Organisation guidelines on good manufacturing practices (GMP) for herbal medicines. Geneva, 2007

Mckenzie A., Sokpo E., & Ager A., (2014). Bridging the Policy Implementation Gap in Federal Health Systems: Lessons from the Nigerian Experience, 5(2) Journal of Public Health in African, 381

Obioha E. E., Ajala A. S., & Matobo T. A., (2010). Analysis of the Performance of Expanded Programme on Immunisation (EPI) for Four Killer Disease under the Military and Civilian Regimes in Nigeria, 1995-1999; 2000-2005, 4(1) Ethno Med Journal, 43

Ukhurebor, K.E., Aidonojie, P.A. (2021). The influence of climate change on food innovation technology: review on topical developments and legal framework. Agric & Food Security **10,** 50. https://doi.org/10.1186/s40066-021-00327-4

Elmer W., Ma C. and White J. (2018) Nanoparticles for plant disease management. Curr Opin Environ Sci Health 6:66–70

Ali M., Ahmed T., Wu W., Hossain A., Hafeez R., Islam Masum M., Wang Y., An Q., Sun G., and Li B. (2020). Advancements in plant and microbe-based synthesis of metallic nanoparticles and their antimicrobial activity against plant pathogens. Nanomaterials 10(6):1146

Elmer W. and White J. C. (2018). The future of nanotechnology in plant pathology. Annu Rev Phytopathol 56:111–133

Gutierrez R. (2014). International Environmental Justice on Hold: Revisiting the Basel Ban from a Philippine Perspective. Duke Environmental Law and Policy, 24, 399 – 419

Kaya Y. (2012). Waste Trade and the Effectiveness of the Legal Arrangements for Transporter Movement of Hazardous Wastes. Journal of economics, Sociology & Politics, 8(2), 65 – 82

Riget, F., Vorkamp, K., Bossi, R., Sonne, C., Letcher, R.J., Dietz, R., (2016). Twenty years of monitoring of persistent organic pollutants in Greenland biota. A review. Environ. Pollut. 217, 114–123.

Falkner R., (2016). The Paris Agreement and the new Logic of International Climate Politics. International Affairs , 92(5), 1107-1125

Ladychenko V., Melnychuk O. & Kanaryk Y. J., (2019). International Mechanism of the Environmental Information Access and Cooperation Framework for Climate Change Protection. European Journal of Sustainable Development 8(4), 131-141

Anderson K, Bows A (2008). Reframing the climate change challenge in light of post-2000 emission trends. Philos Trans A Math Phys Eng Sci 366(1882): 3863–82. doi:10.1098/rsta.2008.0138

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RESEARCH ARTICLE

FDI flow in Energy Sector among BCIM, BIMSTEC+1 and ASEAN+4 sub-regional Alignments

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Abstract

Foreign Direct Investment is the most dynamic component for boosting trade among different sub-regional blocs. It may be considered under Mode 3 of the General Agreement on Trade in Service agreement. This study documents various restrictions under market access and national treatments under mode 3 as committed by different member countries, among three regional trading blocs to improve the energy sector. A large portion of trade is being facilitated through a strong linkage between service trade and Foreign Direct Investment flow among countries or regions. ASEAN countries in South East Asia played an important role in attracting foreign direct investments for the economic development and growth in Energy Sector. Trade barriers, particularly commitment barriers of importing countries, have a strong negative impact on a smooth flow of investments across regions. This research also reviews the purposes of Foreign Direct Investment among regional countries and explores the deepest and strong relationships among regional members to explore a possible strategic relationship for the formation of a Regional Trade Agreement.

Keywords: Foreign Direct Investment; General Agreement on Trade in Service agreement; Association of South East Asia; Centre for Policy Dialogue; ASEAN Free Trade Area

Introduction

South and East Asia have a long history of sub-regional cooperation. Formal economic and cultural cooperation among the countries of the South and East Asian region dates back to early 1960s, when the Association of South East Asia (ASA) was formed in 1961 by the Philippines, Thailand, and the Federation of Malaya (now part of Malaysia), is one of the earliest examples of such alliance in Asia. But South & East Asia have become a critical part of the world trading system since 1978 when China initiated its economic reform. Over the years, East Asia has emerged as the world's fastest-growing economy. Along with Japan, China and the Republic of Korea have emerged as the other two economic forces in East Asia (Aparna etal, 2015). Meanwhile, the South Asian countries took an initiative to develop a sub-regional alliance among them.

ASEAN+4: In 1967, ASA was replaced by the Association of Southeast Asian Nations (ASEAN), established by the governments of Indonesia, Malaysia, the Philippines, Singapore, and Thailand to accelerate economic growth, social progress, and cultural development and to promote peace and security in Southeast Asia. Brunei joined ASEAN in 1984, followed by Vietnam in 1995, Laos and Myanmar in 1997, and Cambodia in 1999. ASEAN Free Trade Area (AFTA) was established in January 1992.

BIMSTEC+1*:* In 1997, BIST-EC (Bangladesh, India, Sri Lanka, and Thailand– Economic Cooperation) formed in Bangkok. Myanmar was admitted in the later part in 1997 and the organization was renamed BIMST –EC. In 2004, Nepal and Bhutan joined in existing group and the name changed to BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation). Its first summit was held in Bangkok in July 2004. BIMSTEC (Bangladesh, Bhutan, India, Myanmar, Nepal, Thailand, and Sri Lanka) was officially formed in 1997 and its secretariat was established in Dhaka in 2014 (Charu Lata Hogg, 2007).

BCIM*:* In 1999, the Centre for Policy Dialogue (CPD) in Bangladesh, Yunnan Academy of Social Sciences (YASS) in Kunming, China, the Centre for Policy Research (CPR) in India, and the Ministry of Border Trade of Myanmar were the pioneering institutions those agreed to launch the BCIM (Bangladesh China India Myanmar) initiative which was initially called the 'Kunming initiative*'* (D. S. Rawat etal, 2016) . It is a Track II (non-government) Regional Trade Facilitation Initiative (RTFI) for bettering economic collaboration within this region.

India has attracted FDI in 4 major energy sectors namely, power, non-conventional, petroleum & natural gas, and electrical equipment, among different countries of three sub-regions. India's total outward FDI in electricity and mining is highest for Singapore, followed by Sri Lanka, China, Bangladesh, Myanmar, and Indonesia (Arif Hussain Malik, 2016). India's FDI inflow to the renewable energy sector mainly comes from Malaysia, Philippines, Japan, and Singapore from South East regions. So, the flow of FDI plays an important role in regional intregation , particularly in energy sector.
The Researcher wants to highlight the following objectives namely

1. To analyze Bilateral Investments Treaties (BITS) among India with other countries among these sub-regions.
2. To analyze thev flow of FDI among three major sub-regions.
3. To examine the movement of FDI among India and other sub-regional countries in Energy, particularly Renewable Energy sector.
4. Analysis of the commitment pattern under Mode 3 (which covers the flow of FDI) among member countries of the three sub-regions.
5. Evaluation of Myanmar's importance as a strategic investment hub for strengthening subregional alignment.
6. To evaluate possible ways for strengthening energy cooperation among regional blocks.

A research gap persists in intra-regional FDI movement across all sectors and particularly in the energy sector among the three sub-regions under study. Research work cannot properly analyze the commitment patterns under Mode 3 (which covers the flow of FDI) among different member countries of respective trading blocs covering energy services. Moreover, research work cannot properly highlight FDI flow of India in both renewable and non-renewable energy across three sub-regions. Myanmar considers a strategic entry point for three sub-regions of India, therefore the study considers Myanmar a special interest for building an investment hub for investing in energy products and services which is ignored in the above literature.
The research paper is divided into five major sections. First Section highlights Bilateral Investments Treaties (BITS) among India with other countries in these regions. Second Section analyzes the flow of FDI among three major sub-regional countries in the Electricity Gas , Water and mining and in Renewable Energy sectors. The third Section examines the commitments pattern under Mode 3 (which covers flow of FDI) among different member countries. Section four analyses the importance of Myanmar a strategic hub for future Investments and the last section examines importance of sub-regions for energy cooperation and flow of FDI among members South East Asian regions.

Literatures Review

Energy and its services are a very important factors among different developed and developing countries in South East Asis to maintain economic growth rate in bilateral and multilateral lavel (Muhammad Naveed Jamil **,** 2022**)** . Regional cooperation among different member countries creates favorable situation for an economic development based on suitable energy service policy and framework (Joachim Monkelbaan, 2013). The degree of liberalization will be evaluated based on trade in services among different countries of ASEAN+n framework and among different modes. FTA frame work applied for evaluation of cross-country and sector-wide similarities in the pattern of service sector commitment level made by different country among ASEAN regions. Existence of limitation on Market access (MA) and National Treatment (NT) by each service sector and simultaneously evaluate commitment level producing sensitive and less sensitive service sector among different FTA across different regions also an evaluating parameter for service cooperation (Ishido, 2012). Foreign direct investment is considered to an important tool for economic growth and integration of regional economy with global economy (ADBI, 2014) . As our regional economy belongs to South East Asian region, So FDI movements along these economies are essential to evaluate overall growth within regions. However, in reality, actual FDI inflows among countries vary due to policy implementation, economical and political scenarios among different countries. The impotence of FDI are rapidly increasing among different countries of ASEAN regions in the context of regional integration processes and overall economic development (Stephen Thomsen, 2011). FDI is one of the major internal source of financing for developed and developing countries among South East Asian regions and it enhances future energy demand by incorporating different technology-based innovations and transfers of technology (Burcak Polat, 2018). Laura Diaconu (2014) examined the trends in ASEAN's inward FDI flow and simultiniously identified different factors which must address and examine for maintaining the current flows and future estimation of investments across the region to maintain growth. Different member countries of South East regions take different initiatives to attract direct and indirect portfolio investments from individual and corporate houses among different member countries for overall regional development. Liberalization of economic policy, incorporation of foreign investments promotion board among different member countries in South East Asian region, and incorporating automatic approval routes are key initiatives for attracting FDI across energy sector (Deepti etal, 2015). India has followed different policy initiatives like economic policy reforms, and liberalized its service restriction to attract more FDI. India considers a major investment hub after China and Japan in South East Asian region. India's inward investments mainly come from Mauritius and Singapore; in

service sector and energy sector. The Service sector has increased its importance in world economy as it's innovation, and incorporation of new technology increased its competitiveness that enhances economic power.India's inward investments (R.B. Teli, 2013). According to Karsenty (2000), mode 1 and mode 3 trade dominate the pattern of international service trade, where each category represents approximately 40% of total service trade and Mode 4 trade plays a marginal role and according to the schedules of the GATS. Renewable energy market in SEA considers a strong economic growth potential due to increasing energy demand and environmental issues among ASEAN member countries. Different forecasting techniques are applied for evaluating future energy demand, particularly in renewable energy sectors and how possible future challenges handled across different countries by attracting FDI (IRENA, 2018). General equilibrium model used to evaluate effect of FDI inflow in energy sector particularly in Central Asia. Result revealed that natural gas sector and non-petroleum based industries would be better off in attracting FDI due to its overall production efficiency with innovative technology and overall terms of trade (Michael P. Barry, 2009).

Methodology

To analyze intra-regional inward and outward FDI flows (across all categories) among three sub regions and for evaluating Bilateral Investment Treaties (BITS), among regional members, an existing FDI related database has been used. And to examine the commitment pattern under Mode 3 (which covers flow of FDI), of different member countries of the three sub-regions under study, the Hoekman indexing method has been used. . The Hoekman Index (Mode 3) has been calculated by country and by aspect for evaluation of Market Acess (MA) and National Treatment (NT) (Kallal etal, 2018). If we observe commitment pattern by mode across regional member countries, the author observed that mode 3 exhibits dissimilarity trend in Market Acess (MA) and National Treatment (NT) (kallal , 2017). The researcher also discussed the gravity model and its relevance in FDI movement. Here, author briefly reviews the earlier literatures of gravity models and relate this work to established theoretical contributions in movement of FDI. For analysis of FDI movements, the study has used data for the year 2010-2020.

Findings and Discussions

Bilateral Invesment Treaties (BITS)

Out of the 18 countries in the regions under study, India has entered into Bilateral Investment Treaties (BITS) with 14 countries. Countries not covered under BITS are: Cambodia, Laos, and Brunei. The oldest BIT entered into was with Singapore in 1965. In the energy sector (Dipankar,2006), India entered into Bilateral Investment Treaties (BITS) with three countries. In 2009, a BIT was signed with Myanmar for duration of 10 years on the energy investment aspect. In 2011, a BIT was signed with Japan on energy-driven technology for 10 years and in 2009 BIT with Korea on power sector for 10-year was signed (Ref Table 1).

Table 1: Bilateral Investments Treaties (BIT) among India with other Countries

Country	Year	Treaty Duration	Energy product & Services	Comment
Bangladesh	2009	10 years	No	In force in social & environmental Investments aspect
Nepal	2011	10 years		Not in force
China	2006	10 years	No	Terminated
Indonesia	2004	10 years	No	Terminated
Malaysia	1997	10 years	No	Terminated
Myanmar	2009	10 years	Yes	In force in social & energy Investments aspect
Philippines	2001	10 years	No	In force
Sri Lanka	1998	10 years	No	In force
Singapore	1965	Renewed in different phases	No	In force
Thailand	2001	10 years		In force
Japan	2011	10 years	Yes (Energy technology)	In force
Vietnam	1999	10 years	No	In force
Korea	2009	10 years	Yes (power)	In force
Bhutan	2006	10 years	No	In force

Source: Invesmentpolicyhub,unctad.org and Ministry of Commerce, Government of India

FDI flow among members of Sub-Regions

The study analyzed FDI stock flow (both inward and outward) among members of three sub-regions (Ref Table 2). The table observes that-

Growth in FDI inflow of Japan has declined 13 percent from year 2012 to 2018. But, growth in FDI outflow of Japan has increased 68 percent from year 2012 to 2018. Growth in FDI inflow of China has increased 130 percent from year 2012 to 2018 and growth in FDI outflow of China has increased 3937 percent from year 2012 to 2018. Growth in FDI inflow of Korea has increased 36 percent from year 2012 to 2018 and growth in FDI outflow of Korea has increased 112 percent from year 2012 to 2018. The Growth in FDI inflow of Indonesia has increased 130 percent from year 2012 to 2018 and growth in FDI outflow of Indonesia has increased 782 percent from year 2012 to 2018. Growth in FDI inflow of Cambodia has increased 130 percent from year 2012 to 2018 and growth in FDI outflow of Cambodia has increased 91 percent from year 2012 to 2018.

Growth in FDI inflow of Singapore has increased 73 percent from year 2012 to 2018 and growth in FDI outflow of Singapore has increased 46 percent from year 2012 to 2018. Growth in FDI inflow of Thailand has increased 35 percent from year 2010 to 2016 and growth in FDI outflow of Thailand has increased 300 percent from year 2012 to 2018. Growth in FDI inflow of India has increased 54 percent from year 2012 to 2018 and growth in FDI outflow of India has increased 48 percent from year 2012 to 2018. Growth in FDI inflow of Sri Lanka has increased 57 percent from year 2012 to 2018 and growth in FDI outflow of Sri Lanka has increased 223 percent from year 2012 to 2018. Growth in FDI inflow of Vietnam has increased 102 percent from year 2012 to 2018 and growth in FDI outflow of Vietnam has increased 346 percent from year 2012 to 2018. Growth in FDI inflow of the Philippines has increased 148 percent from year 2012 to 2018 and growth in FDI outflow of the Philippines has increased 576 percent from year 2012 to 2018. Growths in FDI inflow among Nepal, Bhutan, Myanmar and Bangladesh have increased 173, 228, 56 and 139 percent respectively from year 2012 to 2018. From the above analysis, it is clear that growth in FDI inflow are highest in Bhutan, Nepal, Bangladesh, Cambodia, China, Philippines and Vietnam among members of three regions. Similarly, growth in FDI outflow is highest for China, Philippines, Vietnam and Thailand among members of the three regions.

Table 2 FDI stock of members among three sub-regions (Millions in USD)

Country	Inward FDI			Outward FDI		
	2012	2018	% Change	2012	2018	%Change
Japan	214880	186714	-13.11	831076	1400694	68.54
China	587817	1354404	130.41	317244	12809755	3937.82
Korea	135500	184970	36.51	144032	306145	112.55
Cambodia	6162	16656	170.30	340	652	91.76
Indonesia	160735	234961	46.18	6672	58890	782.64
Lao	1888	5639	198.68	12	19	58.33
Malaysia	101620	121621	19.68	96964	126937	30.91
Myanmar	14507	22666	56.24	-	-	-
Philippines	25896	64249	148.10	6710	45377	576.26
Singapore	632760	1096320	73.26	466129	682404	46.40
Thailand	139286	188651	35.44	21369	85636	300.75
India	205580	318502	54.93	96901	144134	48.74
Sri Lanka	6190	9745	57.43	351	1136	223.65
Vietnam	57004	115391	102.43	2234	9978	346.64
Nepal	239	653	173.22	-	-	-
Bhutan	52	171	228.85	-	-	-
Bangladesh	6072	14539	139.44	-	-	-

Source**:** UNCTAD World Investment Report in 2020

FDI flow among ASEAN

Table 3 shows that intra ASEAN FDI flow in the sub-region has declined from 22% in 2010 to 20% in 2016. China's FDI flow in the sub region has declined from 2.02% in 2008 to 0.70% in 2016. India's FDI flow in the sub-region has increased from 3.21% in 2010 to 7.52% in 2016. Japan's FDI flow in the sub-region has increased from 9.14% in 2010 to 11.35% in 2016. Korea's FDI flow in the sub-region has increased from 3.27% in 2010 to 3.79% in 2016. EU's FDI flow in the sub-region has increased from 20.44% in 2010 to 24.83% in 2016.

Table 3: ASEAN: Total FDI Inflows, by Source (USD million)

Country	2010	2012	2014	2015	2016	Share in 2016	Share in 2010
Intra ASEAN	10449	15200	20548	19400	24377	20.68	22.29
China	946	4053	5718	6779	820	0.70	2.02
India	1506	3474	4299	1330	8869	7.52	3.21
Japan	4285	11171	21206	21766	13381	11.35	9.14
Korea	1533	4298	1577	3652	4469	3.79	3.27

Rest of World	16714	25450	36855	32142	34692	29.43	35.65
EU	9445	19018	6543	22256	29269	24.83	20.14

Source: ASEAN Integration Report, 2015

Sector-wise FDI inflow among ASEAN, Japan, China and Korea

The study analyzed FDI inflow among four major economic and ASEAN region in the different key sectors (Ref Table 4). In the mining sector, FDI inflow in 2015-16 among ASEAN region constitute 0.90 percent of total FDI inflows to this region. India's inflows constitute 1.65 percent, Korea's inflows constitute 0.17 percent and Japan's inflows constitute 0.09 percent respectively out of total FDI inflows among individual countries in this sector. In the electricity and gas sector, FDI inflow among ASEAN region constitutes 0.28 percent out of total FDI inflows to this region. India's inflows constitute 3.75 percent; Korea's inflows constitute 0.66 percent respectively out of total FDI inflows by individual country in this sector. In the mining and electricity sectors combined FDI inflow in China constitute 7.72 percent out of total FDI inflows to this country. In Construction sector FDI inflow among ASEAN region constitute 0.25 percent out of total FDI inflows to this region. India's inflows constitute 11.48 percent, Japan's inflows 0.77 percent and China's inflows constitute 2.19 percent respectively out of total FDI inflows by individual country in this sector. But Korea's inflow decreased by 0.43 percent out of total FDI inflows by individual country in this sector. In the manufacturing sector, FDI inflow among ASEAN region constitutes 4.17 percent out of total FDI inflows to this region. India's inflows constitute 23.40 percent, Korea's inflows constitute 51.28 percent, China's inflow constitutes 15.24 percent and Japan's inflows constitute 63.21 percent respectively out of total FDI inflows by individual country in this sector. In transportation sector, FDI inflow among ASEAN region constitute 0.35 percent out of total FDI inflows to this region. India's inflows constitute 3.78 percent, Japan's inflows 8.57 percent and Korea's inflows constitute 4.13 percent respectively out of total FDI inflows by individual member countries in this sector.

Table 4: Sector-wise FDI inflows of ASEAN, Japan, China, and Korea on Energy sector in 2015-16 (USD Millions)

Sector	ASEAN	% of Total	Korea	% of Total	India	% of Total	Japan	% of Total	China	% of Total
Mining and quarrying	1089.6	0.9	13	0.17	596	1.65	15.9	0.09	10440	7.7
Electricity, Gas	345.6	0.28	50	0.66	1364	3.78		0	-	-
Transportation	420.4	0.35	315	4.13	1363	3.78	1520.7	8.57		0
Construction	301.2	0.25	-33	-0.43	4141	11.5	136	0.77	2983.4	2.2
Manufacturing	5072.3	4.17	3909	51.28	8439	23.4	11219.7	63.21	20670.2	15.24
Information and Communication	1408.4	1.16	511	6.7	2638	7.31	966.7	5.45	11932	8.8
Total	121621.1		7623		36068		17749.5		135610	

Source: OECD FDI data, https://en.portal.santandertrade.com, https://dipp.gov.in, RBI database and China's investment report 2016-17.

FDI flow between India and other countries among sub-regions

India has attracted FDI in 4 major energy sectors namely power, non-conventional, petroleum & natural gas and electrical equipment (Ref Table 5). In the power sector India attracted highest FDI USD 10476 millions followed by petroleum and natural gas USD 6675.76 millions, Non Conventional energy USD 4397.94 millions and in electrical instruments USD 4336.72 millions. Though power sector tops the list, Non-Conventional energy has attracted substantial FDI in recent years. 100 per cent FDI is allowed in India under automatic route for renewable power generation and distribution projects.

Table 5: FDI (million US$) attracted by India in the different energy sectors

Sectors	2000-01	2009-10	2017-18	Total
Power	89.42	1271.79	868.8	10476.15
Petroleum & Natural Gas	9.35	265.53	103.02	6675.76
Non-conventional Energy	0	622.52	776.51	4397.94
Electrical Equipment	79.76	728.27	444.88	4336.72

Source: Economic outlook report on SEA, 2018

The non-conventional energy sector of India has received a total FDI equity inflow of US$ 6.01 billion during April 2000 to September 2017 from different countries of the world. However, majority of FDI inflow in renewable energy sector came from Mauritius, USA and Japan to India.

FDI flow among India and BCIM

Thanks to China, India's inward FDI (in values and stocks) from BCM countries increased over years. However, outward FDI flow to BCM shows wide fluctuations. Bangladesh and Myanmar are the major losers .So India's Net investments flows towards BCM regions were negative in values initially i.e in year 2010, 2011, and 2013 but in later periods i.e in year 2014 and 2018 increased slowly (Ref Table 6)

Table 6 India's Net FDI in BCM countries over time

Year	Inward Investments in Values (million US $)	Outward Investments in Values (million US $)	Net Investments in Values(Million US $)
2010	1.55	27.89	-26.34
2011	73.36	114.25	-40.89
2012	148.16	69.05	79.11
2013	121	124.19	-3.19
2014	505	87.63	417.37
2018	461	99.78	361.22

Source: OECD database, RBI, Investmentpolicyhub, World Bank, DIPP.gov.in

FDI flow amonmg India BIMSTEC+1

Inward FDI into India has increased during 2010-2018, which mainly comes from Japan. No other BIMSTEC+1 country had made any significant amount of investments in Indian. However, there was a steady decline in India's investment in BIMSTEC+1 region during this period. Indian investments in Sri Lanka, Thailand, Myanmar and Bangladesh declined in year 2014 and 2018. India's Net Investment flows towards BIMSTEC+1 region were positive in values from 2011 to 2018 except in 2010. Net investments flow reached highest level in year 2014 in BIMSTEC+1 region (Ref Table 7).

Table 7 India's Net FDI in BIMSTEC+1 countries over time

Year	Inward Investments in Values (million US $)	Outward Investments in Values (million US $)	Net Investments in Values(Million US $)
2010	1260.78	1272.1	-11.32
2011	2096.03	589.97	1506.06
2012	1345.91	273.65	1072.26
2013	1795	226.87	1568.13
2014	2019	164.35	1854.65
2018	1818	174.78	1643.22

Source: OECD database, RBI, Investmentpolicyhub, World Bank, DIPP.gov.in

FDI flow among India and ASEAN+4

Thanks to Singapore, Japan and China, India's inward FDI from ASEAN+4 regions has increased substantially during 2010-2018. However, India's investment graph in ASEAN+4 regions shows wide fluctuations during this period. India's outward investments to Singapore is highest followed by Malaysia and Indonesia. India's Net Investments flows towards ASEAN+4 regions were negative in initial period i.e in 2010 then fluctuation observed in later years. Net investments flow reached highest level in year 2018 in ASEAN+4 regions (Ref Table 8).

Table 8 India's Net FDI in ASEAN+4 countries over time

Year	Inward Investments in Values (million US $)	Outward Investments in Values (million US $)	Net Investments in Values(Million US $)
2010	2934.82	4166.86	-1232.04
2011	5695.33	2773.54	2921.79
2012	3321.78	2145.17	1176.61
2013	6520	5144.22	1375.78
2014	7799	6842.5	956.5
2018	14999	5610.5	9388.5

Source: OECD database, RBI, Investmentpolicyhub, World Bank, DIPP.gov.in

FDI flow between India and other sub-regional countries in Electricity. Gas, water and mining

India's outward FDI in different countries of three regions (BCIM, BIMSTEC+1 and ASEAN+4) increased over years in electricity, gas, water and mining sector [4]. India's outward FDI was higher in mining compared to electricity. India's total outward FDI in electricity was USD 258.35 million and in mining USD 8094.318 million over years of 2013 to 2017. So total outward of India's FDI in energy sector has been increased from USD 575.14 million to USD 3096.16 million during 2013-16. However, in 2017 outward FDI of India decreased to USD 1891.42 million (Ref Table 9). In electricity sector, India's outward FDI to Singapore is highest USD 236.16 million followed by Bangladesh USD 13.82 million, Bhutan USD 2.04 million and in Sri Lanka USD 1.70 million over year 2013 to 2017.In 2013 India's total outward FDI was USD 112.36 million and decreased in 2014 USD 18.80 millions. In 2015 outward FDI again increased to USD 109.83 million and again decreased to subsequent years (Ref Table 10). In mining sector, India's outward FDI to Singapore was highest USD 7963.56 million, followed by Sri Lanka USD 68.98 million, China USD 25.95 million, Philippines USD 9.81 million, Myanmar USD 7.01 million, Indonesia USD 5.75 million, Bangladesh USD 5.35 million, Cambodia USD 2.65 million, Laos USD 2.62 million USD 1.38 million, Bhutan USD 1.38 million, Nepal USD 0.95 million, Malaysia USD 0.25 million, Japan USD .09 million, Thailand USD 0.29 million and Vietnam 0.23 million over year 2013 to 2017 (Ref Table 11). India's total outward FDI in both electricity and mining was highest to

Singapore USD 8199.72 million, followed by Sri Lanka USD 70.69 million, China USD 9.82 million, Bangladesh USD 19.17 million, Philippines USD 9.82 million, Myanmar USD 7.01 million, Indonesia USD 5.75 million, Nepal USD 5.55 million, Bhutan USD 3.43 million, Cambodia USD 2.65 million, Laos USD 2.62 million, Malaysia USD 0.25 million, Japan USD 0.11 million, Thailand USD .029 million and Vietnam USD 0.023 million from year 2013 to 2017 (Ref Table 12).

Table 9: India's Outward FDI to in Electricity Gas and Water and Mining in South East Asia (In USD Millions)

Year	Outward FDI from India to SEA (Electricity Gas and Water)	Outward FDI from India to SEA in Mining
2013	112.3655	462.7749
2014	18.8073	1133.2545
2015	109.83687	1528.0439
2016	3.1567	3093.0053
2017	14.1878	1877.2398

Source: OECD service and FDI database

Table 10 : India's Outward FDI in Electricity Gas and Water (In USD Millions)

Year	Sri Lanka	Nepal	Singapore	Bhutan	Japan	Bangladesh	Total
2013	0.45	0.3517	109.5218	2.042	NA	NA	112.3655
2014	0.616	0.1442	16.4861	NA	0.005	1.556	18.8073
2015	0.3285	0.0957	109.41267	NA	NA	NA	109.8369
2016	0.2705	0.0564	0.6049	NA	NA	2.2249	3.1567
2017	0.0432	3.9534	0.135	NA	0.016	10.0402	14.1878
Total	1.7082	4.6014	236.16047	2.042	0.021	13.8211	

Source: OECD service and FDI database

Table 11: India's Outward FDI to SEA in Mining (In USD Millions)

Year	Singapore	Sri Lanka	Myanmar	Indonesia	Nepal	Philippines	Bhutan	Bangladesh	Lao
2013	434.1827	19.4201	2.309	1.8805	0.0334	0.409	0.374	0.4362	0.3424
2014	1108.9776	5.7879	0.5395	0.475	0.2307	8.4025	0.4472	0.2996	1.0913
2015	1496.63	24.4901	0.1688	0.47	0.2057	-	0.4177	0.3825	0.564
2016	3065.6675	12.1942	0.6641	1.2205	0.3479	0.5023	0.024	-	0.5643
2017	1858.1	7.0938	3.325	1.7084	0.1306	0.502	0.126	4.2379	0.06
Total	7963.5578	68.9861	7.0064	5.7544	0.9483	9.8158	1.3889	5.3562	2.622

Year	Malaysia	Cambodia	China	Japan	Vietnam	Thailand	Total
2013	0.0628	0.1	3.224	0.0008	-	-	462.7749
2014	0.0942	-	6.909		-	-	1133.255
2015	0.0628	0.42	4.224	0.0083	-	-	1528.044
2016	0.0275	0.17	11.6		0.023		3093.005
2017	0.0029	1.9663		0.083	-	0.0299	3894.366
	0.2502	2.6563	25.957	0.0921	0.023	0.0299	

Source: OECD service and FDI database

Table 12: India's outward FDI among different member countries of BCM, BIMSTEC+1 and ASEAN+4 in both Electricity Gas and Water and Mining from 2013 to 2017 (In USD Millions)

Country	2013	2014	2015	2016	2017	Total
Singapore	543.7045	1125.4637	1606.043	3066.272	1858.235	8199.718
Sri Lanka	19.8701	6.4039	24.8186	12.4647	7.137	70.6943
Nepal	0.3851	0.3749	0.3014	0.4043	4.084	5.5497
Bhutan	2.416	0.4472	0.4177	0.024	0.126	3.4309
Japan	0.0008	0.005	0.0083	-	0.099	0.1131

Bangladesh	0.4362	1.8556	0.3825	2.2249	14.2781	19.1773
Myanmar	2.309	0.5395	0.1688	0.6641	3.325	7.0064
Indonesia	1.8805	0.475	0.47	1.2205	1.7084	5.7544
Philippines	0.409	8.4025	-	0.5023	0.502	9.8158
Laos	0.3424	1.0913	0.564	0.5643	0.06	2.622
Malaysia	0.0628	0.0942	0.0628	0.0275	0.0029	0.2502
Cambodia	0.1	-	0.42	0.17	1.9663	2.6563
China	3.224	6.909	4.224	11.6	-	25.957
Vietnam	-	-	-	0.023	-	0.023
Thailand	-	-	-	-	0.0299	0.0299

Source: OECD service and FDI database

FDI in the renewable energy sector

From 2009 to 2016, approximately USD 6 billion was invested by different development banks in Southeast Asia on renewable energy-based projects. The World Bank invested USD 1.75 billion, Asian Development Bank invested USD 1.16 billion, Japan Bank for International Cooperation (JBIC) invested 1.06 billion, Japan international cooperation agency (JICA) invested 0.52 USD billion, International financial cooperation invested 0.35 USD billion and EXIM Bank invested 0.18 USD billion for development of renewable based energy projects in South East Asia (Renewable Energy Report, SEA, 2018). Among different countries of SEA, Indonesia received 60 percent of cumulative investments for the developments of geothermal projects (E.M. Remolona etal, 2005). Other ASEAN countries namely Philippines, Thailand, Vietnam and Lao attracted investments for the developments of renewable energy based projects with collaboration of ADB and JBIC (Janaka Wijayasiri etal, 2008). World Bank and JICA started financial support to Myanmar for the developments of power plant on the renewable energy generation and distribution in SEA regions. Annual investments in 2015 on renewable energy sector in the Asian region was nearly ten times higher than it was in 2004, increasing from USD 19 billion to USD 179 billion. China raised its investment in the renewable energy sector from USD 3 billion in 2004 to USD 102.9 billion in 2015 and India has increased its investment in this sector by 22% from 2014 reaching USD 10.2 billion in 2015 (UNCTAD , 2013). Policy maker expect that by the year 2040, almost 49 per cent of the total electricity in India will be generated from renewable energy resources and efficient batteries will be used to store electricity which will further cut the solar energy cost by 66 percent as compared to its current cost (UNCTD and ASEAN, 2017). It is claimed that the use of renewable energy, in place of non-renewable like coal, gas etc. will save India's exchequer US$ 8.43 billion per annum (Zhaoli Wu, 2014).

FDI in renewable energy among ASEAN

Largest recipients of FDI in renewable energy projects in SEA were India (USD 24688 million), China (USD 13555 million) and Indonesia (USD 11930 million) from 2003 to 2016.More than 60% of the total energy related FDI received by the member countries in this region came in form of renewable energy. Renewable energy sector of India received approximately USD 3.2 billion FDI from 2015 to 2018. India attracted FDI in renewable energy of USD 25886 million mainly came from European countries, Non OECD members, China and Singapore. China's FDI USD 13555 million comes from European countries, Non OECD members and Singapore. FDI of Indonesia USD 11930 million comes from Singapore, China, Non OECD members, Malaysia. Philippines's FDI inflow in renewable energy comes from China, Singapore Thailand and other OECD countries [20]. All member countries of ASEAN together received investments of USD 24347 million in renewable energy. Brunei and Singapore are least attractive countries to attract FDI in renewable energy sector, USD 409 million and USD 946 million respectively. The Euro area seems to be the main investor with 28.7% of the total investments in ASEAN regions.

India's inward and outward FDI in renewable energy

India's FDI inflow from SEA countries, in renewable energy sector, mainly comes from Malaysia, the Philippines, Japan and Singapore. Indian companies have tied up with different foreign collaborators like Mudajaya Group Berhad from Malaysia, ORIX Corporation from Japan, Asian Development Bank, AIRRO Singapore Pvt Ltd of Singapore to attract FDI equity inflow. FDI equity inflow in renewable energy is highest from Japan, USD 90.94 millions, followed by Malaysia USD 77.18 million, the Philippines USD 44.69 millions and Singapore USD 41.07 millions (Ref Table 13)

Table 13: India's inward FDI from SEA in renewable energy sector in 2017

Foreign Collaborator	Country	Indian Company	FDI Equity Inflow (US$ millions)
Mudajaya Group Berhad	Malaysia	RKM Powergen Pvt. Ltd.	77.18
ORIX Corporation	Japan	TADAS Wind	53.23

		Energy Pvt. Ltd	
Asian Development Bank	Philippines	Renew Power Ventures Pvt. Ltd.	44.69
AIRRO Singapore Pte Ltd	Singapore	Diligent Power Pvt. Ltd.	41.07
ORIX Corporation	Japan	Lalpur Wind Energy Pvt. Ltd.	37.75

Source: Economic outlook report on SEA, 2017

India's investment in renewable energy is USD 13.7 billion in 2018 to ASEAN regions. Out of India's total investments, USD 4.6 billion were invested in solar power, while USD 4.1 billion invested in wind power projects (Ref Table 14).

Table 14: Outward Investments of India in renewable energy sector over 2009-2018

Year	Investment in USD billion
2009	4.2
2010	9
2011	13.8
2012	8
2013	6.8
2014	8.4
2015	9.9
2018	13.7

Source: https://www.irena.org/financeinvestment (2019)

China is the global leader in terms capacity related to hydropower, solar PV, wind power and solar water heating in renewable energy sector. Several global renewable power plant equipment manufacturing companies mainly from China and Japan have formed Joint Ventures with Indian Companies for establishing manufacturing base in India for manufacture of boilers/turbine, storage device with technological collaboration.

Analysis of commitments under mode 3 among sub-regions

BCIM region

Evaluation of commitment levels of BCIM countries in Mode 3 for energy services (Ref Table 15): Average Hoekman scores under Mode 3 for BCIM region are 0.0273(MA) and 0.0422(NT). The respective scores for India and China are: 0.0116(MA), 0.0136(NT) and 0.0157 (MA), 0.0286 (NT) respectively. China opened up their MA through joint venture mode in different energy services (kallal et.al, 2018) like management consulting services, energy related scientific and technical consulting services, long distance transmission through pipeline and repair services etc. India also opened up their MA through offering 51% FDI in engineering and integrated engineering services, research and experimental development services and long distance transmission through pipeline etc.

Table 15 Commitment pattern of BCIM countries in Mode 3 among energy services

Country	1.A.e	1.A.f	1.C.a	1.F.c	1.F.d	1.F.e	1.F.h	1.F.i	1.F.j
China MA	Unbound	Unbound	Unbound	JV(50%)	Unbound	JV(50%)	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	FL	Unbound	FL	Unbound	Unbound	Unbound
India MA	51%	FL	51%	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	FL	FL	FL	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Myanmar MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Bangladesh MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound

1.F.m	1.F.n	1.F.t	3.B	3.E	4.A	4.C	11.G.a
JV(50%)	Unbound	Unbound	JV(50%)	JV(50%)	JV(50%)	Unbound	Unbound
FL	Unbound	Unbound	FL	FL	FL	Unbound	Unbound

Unbound	Unbound	Unbound	51%	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	FL	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound

Source: country wise WTO commitment list

BIMSTEC+1 regions

Evaluation of commitment levels of BIMSTEC+1 country in Mode 3 in energy services (Ref Table 16): It is observed that average Hoekman scores are better than BCIM at 0.1719(MA) and 0.1792(NT). Average Hoekman Index scores of Mode 3 for Japan are 0.6667 (MA), 0.6111(NT), Thailand 0.4444 (both for MA and NT) and Nepal 0.2530(MA), 0.3640(NT). Japan opened its MA in energy related scientific and technical consultancy, services related to management consulting, repair service for long distance pipelines, communication and power lines (cables), wholesale trade services of solid, liquid and gaseous fuels and related products etc. Thailand Opened their MA in different energy services like management consulting services, technical testing and analysis services, service incidental to mining, transmission in long distance pipeline etc. Nepal opened its MA by allowing 51 percent FDI in engineering and integrated engineering services and 66 percent in research and experimental development services, management consulting services, transmission in long distance pipeline, services incidental to mining and repair services.

Table 16 Commitment pattern of BIMSTEC+1 countries in Mode 3 among energy services

Country	1.A.e	1.A.f	1.C.a	1.F.c	1.F.d	1.F.e	1.F.h	1.F.i	1.F.j
Myanmar									
MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Bangladesh									
MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Japan MA	Unbound	Unbound	Unbound	FL	FL	FL	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	FL	FL	FL	Unbound	Unbound	Unbound
Thiland MA	FL	Unbound	Unbound	FL	Unbound	FL	FL	Unbound	Unbound
NT	FL	Unbound	Unbound	FL	Unbound	FL	FL	Unbound	Unbound
Nepal MA	51%	51%	51%	51%	51%	Unbound	51%	51%	Unbound
NT	FL	FL	FL	FL	FL	Unbound	FL	FL	Unbound
Bhutan MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Sri Lanka MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
India MA	51%	FL	51%	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	FL	FL	FL	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound

1.F.m	1.F.n	1.F.t	3.B	3.E	4.A	4.C	11.G.a
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound

Unbound	FL	FL	FL	FL	FL	FL	Unbound
Unbound	FL	FL	FL	FL	FL	FL	Unbound
Unbound	FL	FL	FL	Unbound	FL	Unbound	Unbound
Unbound	FL	FL	FL	Unbound	FL	Unbound	Unbound
Unbound	51%	Unbound	51%	51%	51%	Unbound	Unbound
Unbound	FL	Unbound	FL	FL	FL	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	51%	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	FL	Unbound	Unbound	Unbound	Unbound

Source: country wise WTO commitment list

ASEAN+4 region

Evaluation of commitment level of ASEAN+4 countries in Mode 3 in energy services(Ref Table 17): It is observed that average Hoekman Index scores of Mode 3 for Cambodia are 0.6944 (MA), 0.7778 (NT), Korea 0.5278 (MA), 0.7233 (NT), Indonesia 0.5278 (both for MA and NT), Malaysia 0.1667 (MA), 0.3334(NT) and Singapore 0.0834(MA), 0.1112(NT). ASEAN+4 average Hoekman scores are better than BCIM and BIMSTEC+1 at 0.2096(MA) and 0.2438(NT). Korea and Vietnam have fully liberalized their MA in engineering services, research and development services, management consultancy services, technical testing, service incidental to mining, energy related scientific and technical consultancy, repair, transmission through pipeline etc. Indonesia has opened up its MA through joint venture in energy services like management consultancy services, repair services, technical testing, and manufacture of coke, refined petroleum products and nuclear fuel on a fee or contract basis. Malaysia has also opened up its MA by allowing 51% FDI in engineering and integrated engineering services, management consulting services and technical testing. Singapore has fully liberalized its market in research and development services and allowed up to 51 percent FDI in engineering services. Cambodia has fully liberalized most of the energy related services under Mode 3

Table 17 Commitment pattern of ASEAN+4 countries in Mode 3 among energy services

Country	1.A.e	1.A.f	1.C.a	1.F.c	1.F.d	1.F.e	1.F.h	1.F.i	1.F.j
Myanmar									
MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Japan MA	Unbound	Unbound	Unbound	FL	FL	FL	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	FL	FL	FL	Unbound	Unbound	Unbound
Thailand MA	FL	Unbound	Unbound	FL	Unbound	FL	FL	Unbound	Unbound
NT	FL	Unbound	Unbound	FL	Unbound	FL	FL	Unbound	Unbound
India MA	51%	FL	51%	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	FL	FL	FL	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
China MA	Unbound	Unbound	Unbound	JV(50%)	Unbound	JV(50%)	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	FL	Unbound	FL	Unbound	Unbound	Unbound
Korea MA	FL	Unbound	FL	FL	FL	FL	FL	Unbound	Unbound
NT	FL	Unbound	FL	FL	FL	FL	FL	Unbound	Unbound

Cambodia									
MA	FL	FL	Unbound	FL	FL	FL	FL	Unbound	FL
NT	FL	FL	Unbound	FL	FL	FL	FL	Unbound	FL
Vietnam MA	FL	Unbound	FL	FL	FL	FL	FL	FL	Unbound
NT	FL	Unbound	FL	FL	FL	FL	FL	Unbound	Unbound
Philippines									
MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Indonesia									
MA	JV	Unbound	Unbound	Unbound	JV	JV	Unbound	JV	Unbound
NT	JV	Unbound	Unbound	Unbound	JV	JV	Unbound	JV	Unbound
Malaysia MA	51%	51%	Unbound	51%	Unbound	51%	Unbound	51%	Unbound
NT	FL	FL	Unbound	FL	Unbound	FL	Unbound	FL	Unbound
Singapore									
MA	51%	Unbound	FL	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	FL	Unbound	FL	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Brunei MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Laos MA	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
NT	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound

1.F.m	**1.F.n**	**1.F.t**	**3.B**	**3.E**	**4.A**	**4.C**	**11.G.a**
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	FL	FL	FL	FL	FL	FL	Unbound
Unbound	FL	FL	FL	FL	FL	FL	Unbound
Unbound	FL	FL	FL	Unbound	FL	Unbound	Unbound
Unbound	FL	FL	FL	Unbound	FL	Unbound	Unbound
Unbound	Unbound	Unbound	51%	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	FL	Unbound	Unbound	Unbound	Unbound
JV(50%)	Unbound	Unbound	JV(50%)	JV(50%)	JV(50%)	Unbound	Unbound
FL	Unbound	Unbound	FL	FL	FL	Unbound	Unbound
FL	FL	FL	FL	FL	FL	FL	Unbound
FL	FL	FL	FL	FL	FL	FL	Unbound
FL	Unbound	Unbound	FL	FL	FL	FL	FL
FL	Unbound	Unbound	FL	FL	FL	FL	FL
FL	FL	Unbound	FL	FL	FL	FL	Unbound
FL	FL	Unbound	FL	FL	FL	FL	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	JV	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	JV	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound

Unbound	Unbound	51%	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	FL	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound
Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound	Unbound

Source: country wise WTO commitment list

Strategic investment in Myanmar

For India, Myanmar is the gateway to the East Asia. Myanmar is a member of all the three sub-regional alignments under study. Around 90% of the Indian FDI in Myanmar has been invested in oil and gas sector only. At least 5 Indian public sector undertakings, namely, ONGC Videsh, Oil India Ltd, Indian Oil Corporation, Petronet, and GAIL are engaged at different stages of activities in Myanmar. Leveraging on Myanmar's experience India may try to expanding energy diplomacy in its neighborhood. To identify potential sub-sectors (from list of energy products in annexure 6.1) and suitable geographic locations for investment the study has applied the following three approaches.

- Statistical approach: Analysis of historical trade data
- Analysis of pull factors: Analysis of resources and government policies conducive for investment
- Analysis of push factors: Leverage on the investments already made.

Statistical methods

Here three approaches have been followed
Analysis of RCA values:
An analysis of RCA values on energy sectors have been identified as ideal sectors for investment in Myanmar would be

- 1 sector where Myanmar has the highest RCA values among the energy products: HS 74. They have already archived their competitive edge. Indian investors can take advantage of the LDC status of Myanmar and low labour cost to export these products from Myanmar.
- 2 sectors of Myanmar where RCA values have improved during the years 2010-2013: HS27 and HS74. These are the rising sectors.
- 1 sector where RCA values have declined during our evaluation period though the RCA remained >1: HS71. Here Indian expertise and capital would be welcome to regain their past glory. Investors may target these sectors also.

Based on RCA analysis, the following 3 energy sub sectors may be selected for investment in Myanmar: HS 27, HS71 and HS74 for more sub-regional cooperation.

Sector Potentiality approach

We have also identified a few sectors that have potential to enter into their partner country.

- On the basis of RCA and RCDA values we could identify that HS27, and HS 74 sectors have the potential to enter into Indian market. If India invests in these sectors, the investors can cater to the expanding NE market of India using border huts and trading points. Otherwise China or other investors will exploit that opportunity.
- Similarly for HS73 sector India has the potentiality to enter into Myanmar. If investment is made in Myanmar, the domestic market of Myanmar will absorb the output of these sectors.

Import substitution approach

- 4 sectors are the major import depending sectors in Myanmar. Stake holders of these sectors, namely, HS 27, HS73, HS84, and HS85 would welcome any package (Technology and Capital) that would help to reduce their import dependence.

Pull Factors

Though the government of Myanmar is earnestly trying to attract FDI and integrate with the SEA market to get out of the shadows of long isolation and sanctions by the western developed countries, international rating agencies and multilateral bodies like the World Banks are not yet optimist about Myanmar. The latest report of the World Bank Group is an example.

Table 18: Ease of doing Business in Myanmar and select East and South East Asian countries

Sl no	Country	Ease of doing business score(out of 100)	Ease of doing business rank(190 countries)
1	Malaysia	80.60	15
2	Indonesia	67.96	73
3	Regional Average (East Asia & Pacific)	63.41	-
4	India	67.23	77

5	Lao PDR	51.26	154
6	Myanmar	44.72	171

Source: World Bank Group, Doing Business ,2019

Myanmar has sought investment –both domestic and foreign in the following sectors:

- Power sector
- Infrastructural development
- Extractive industry(minerals/oil and gas)

Indian firms have exposure in infrastructural development (Sittwe port) and oil and gas sector. The experience of the existing investors may help others to venture into these sectors.

But Myanmar offers huge potential for Indian minerals and mining companies/institutions. The experience of Geological Survey of India would be very useful for making a foothold in the lucrative mining sector. Please refer to annexure 8.1 to assess the huge potential of the mining resources of Myanmar. But unlike this loot of resources, India's approach should be to assist Myanmar in their sustainable long term development of mines for bettering of the nation not just exploitation and appropriation of natural resources.

Large scale reform in the State-owned Economic Enterprises (SEE) is another area where huge opportunities await Indian expertise. There are several state-owned economic enterprises (SEEs) in Myanmar authorized to keep other accounts (OAs), which hold around $9 billion..

Push Factors*: Leverage on investments already made:*

India has invested in two main sectors (i) Oil and Gas–in the form of FDI and (ii) infrastructure.

Oil and gas sector in Myanmar

Myanmar attracts maximum FDI in oil and gas sector, followed by power sector. Around 90% of the Indian FDI in Myanmar has been invested in oil and gas sector only.

With India's vast experience and expertise in oil and gas industry, from exploration to exploitation and from refining to distribution, India may focus more extensively in this highly potential sector. In near future, fund rich State-owned Economic Enterprises (SEEs) are likely to be privatized through Public Private Partnership (PPP) mode. Indian firms may bid for SEEs related to oil and gas.Myanmar needs electricity for development. It is a supply demand gap. And demand for fertilizer is increasing steeply. With India's expertise in the production and generation of gas based fertilizer and electricity the government may consider to utilise discovered natural gas, instead of monetizing it by selling to China, for the production of fertilizer and generation of electricity in Myanmar itself.

Road and port infrastructure

India may take advantage of the road and port infrastructure it has contributed to build in Myanmar. To begin with, two major connectivity projects namely-Kaladan Multi Modal Transit Transport Project [1] and India-Myanmar-Thailand Trilateral Highway project (which is a part of the Asian Highway Network) may be considered for meaningful economic engagement with Myanmar. Another important road- the Stillwell Road (the Ledo Road) which connects Upper Assam with Kunming(China)via Upper Burma, may also play an important role in promoting India's economic ties with Myanmar, China, Lao and other east Asian countries. But immediate investment plan, along that route, may be kept on hold due to poor condition of the road.

Evaluation of sub-regional alignment in FDI flow

A Major problem in the field of service trade and FDI flow are the lack of relevant data for formulating any econometric model. However, many researchers used sectoral service trade and FDI movement data over different years for generating different models, particularly on FDI flows as well as relevant barriers ampong the regional level. Here researcher used baseline gravity equations for evaluating the impact of regional FTA particularly on energy-based services and flow of FDI.

$$FDI_{ij} = \infty + \beta_1 d_{ij} + \beta_2 Y_i + \beta_3 Y_j + \beta_4 YC_i + \beta_5 YC_j + \beta_6 FTA_{ji} + \beta_7 TRI_j + \epsilon_{ij} \text{ ---------(eq no1)}$$

The variables FDI represent outgoing FDI stocks from country i to country j in 2020. The explanatory variables are as follows: dij represents the geographical distance among exporting and importing country, yi is GDP of country i , yj is GDP of country j, yci is GDP per capita of country i, ycj is per capita of country j, FTAij is a dummy variable taking 1 if the two countries i and j are linked through a regional free trade, zero otherwise. The trade restrictiveness variable trij is a measure of the barriers to service trade and FDI in country j.

Formation of gravity equation requires data on bilateral trade value among countries, GDP value of individual country, distance between two countries, populations of different countries etc. Bilateral trade flows have been captured from the UN's COMTRADE database or from the World Bank's Trade data. GDP in current US dollars was gathered from the IMF's International Financial Statistics or the World Bank's World Development Indicators (WDI). For distances data, the geodesic distances between capitals or the largest cities of each country are available from the Centre Etudes Prospective Information's International (CEPII), along with other geographic and trade-related variables[2]. Total import

[1]http://mdoner.gov.in/infrastructure/kaladan-multi-modal-transit-transport-project-inland visited on 26.12.2018

[2] The CEPII database can be accessed at http://www.cepii.fr/anglaisgraph/bdd/distances.htm visited on 05/07/2021

data covering 712 rows among bilateral trades for the year 2020 have been used for the estimation of FDI in energy service model. All regression models estimators are estimated using Ordinary Least Squares and Fixed effect methods.

Table 19: Results of parameters using Gravity model

Parameters	Base line Gravity Equations
GDP_Parent	1.39 *** (0.05)
GDP_Host	0.81 *** (0.07)
Distance	-0.49 *** (0.12)
Trade barriers H	-0.36 * (0.27)
Regional FTA	0.67 *(0.03)
Constant	-4.69 *** (1.08)
Number of obs	712
F-stats	195.86
Prob > F	0.000
Adjusted R^2	0.6844
Root MSE	1.3476

Source: Result generated from STATA
standard errors in parenthesis *** = 0.01 sign. level ** = 0.05 sign. level * = 0.1 sign. Level

Model is based on OLS regressions method where author distinguish among exporting and importing countries GDP. The GDP coefficients are highly significant at 90 percent level and show that there is a clear home market effect in both the FDI flow (i.e. the parent GDP coefficient is larger than the host country GDP coefficient).
Service trade barriers have a significant negative effect on service exports and FDI flow. Regional FTA formation has positibve coffecient and has increased FDI flow approximately 94 percent level in energy services.

Possibility of regional energy cooperation

Some of the member States among three regions, namely Nepal, Myanmar and Bangladesh etc. still lack in terms of access to electricity. These countries have tried to develop energy infrustructure in the last few years, but there is still a large population among these regions are left without electricity. Very low access and availability of electricity enhance possible potentiality for regional energy cooperation. Main driver for regional energy cooperation includes importing power from other countries, expanding grid connectivity and providing financial support for boosting energy generation and distribution.
Some member countries among these sub-regions have positive synergies in the development of technology based power plant, operation, transmission and balancing the regional grid. The geographically interconnected region should allow rerouting high capacity transmission lines through another country for point-to-point grid connection, essential for regional energy cooperation. Some renewable energy based countries don't have sufficient storage of hydro and gas plants for grid balancing. There is a scope of possibility of utilization of storage-based hydro-power plants in countries namely Nepal, Bhutan and Myanmar; and gas power plants in countries like Myanmar and Bangladesh for renewable energy integration through regional grid balancing.

Technology transfer on energy sector

Modern IOT based technologies such as smart grid, electric mobility and electricity storage moving from technology-based demonstration phase to commercial implementation in different level, there is scope for energy technology transfer as one of the important driver of regional cooperation. These can enhance for implementation of commercial based projects with inward FDI. One of the greatest technology transfer is observed in the case of Rooppur Nuclear Power Plant which is under construction is in Bangladesh. With collaboration of the Japanese technology and investment and the similar technology was deployed and commissioned successfully in India's Kudankulam Nuclear Power Plant. So along with technology transfer, FDI movement plays an important role for regional cooperation.

Research and development in energy sector and FDI movement

Regional member countries can undertake joint research and development initiatives in new energy technologies, and strengthen investment flow, which could act as an enabler of regional cooperation. There are enough scope of research and development namely clean coal, sustainable hydropower, and renewable energy integration etc. Different research institutions in these regions can collaborate with different financial institutions to enhance technology based research and open up future flow of FDI among these sub-regions.

Regional stability and peace

Regional energy cooperation has geostrategic implications, and often has interlinkages with political stability and peace. In regions where relations between the countries are not cordial,it is difficult to start or sustain energy cooperation. On the other hand, almost all the well- established examples of regional energy cooperation have the underlying factors of regional stability and peace as a enabler and drivers, for energy cooperation. One of the major advantages of regional grouping is that there is no significant political enmity or a history of adverse relations between the member States. The region is peaceful, and free from any major international conflicts. Even within the individual Member States, there is political stability. This aspect serves as a key driver for

energy cooperation, and serves as an opportunity for strengthening the cooperation.

Conclusion

In energy sector India entered into Bilateral Investment Treaties (BITS) with three countries out of 18 countries of the three sub-regions. India received maximum FDI, across all sectors, from Singapore followed by Japan, China and Korea from South East Asian countries. Steady FDI flow has been observed in case of Japan, Singapore and Korea. More than twenty per cent of total FDI inflows into ASEAN regions come from EU countries. Among ASEAN countries Japan considered as single largest investor to India among ASEAN region. India's inward investments in Energy sector is very low (Ninth position in Power sector and fifteenth in Petroleum & Natural Gas sector) among 16 major sectors. India has attracted FDI in 4 major energy sectors namely, power, non-conventional, petroleum & natural gas and electrical equipment, among different countries of three sub-regions. India's investment in the renewable energy was USD 13.7 billion in 2016 among ASEAN regions. India's FDI inflow to renewable energy sector mainly comes from Malaysia, Philippines, Japan and Singapore from SEA countries. Out of India's total investments in renewable energy, USD 4.6 billion was invested in solar power, while USD 4.1 billion invested in wind power projects. India's total outward FDI in both electricity and mining is the highest in Singapore, followed by Sri Lanka, China, Bangladesh, Myanmar, Indonesia etc. Under this study, researcher observed that, India and Myanmar are the only two countries that are members of all three sub-regions under study. The study also suggests that Myanmar as the strategic gateway for Indian business to South East Asia. In this research author has examined aggregate FDI flow under mode 3 in energy services within the gravity model framework. In the model author finds a strong negative effect of barriers to service trade on service exports and FDI. Removing these barriers may increase flow of FDI in future time period through more liberalization of MA and NT. GDP has significant positive effects on FDI flow, and author also identifies a strong linkage among home market as well as partner countries that probably indicates that FDI flows are highly heterogonous in nature.

Cambodia has fully liberalized most of the energy related services under Mode 3 which attracts more FDI. Average Hoekman scorer under mode 3 in ASEAN+4 sub-regions are better than BCIM and BIMSTEC+1 sub-region. Korea and Vietnam have fully liberalized their MA (Market Access) in engineering services, research and development services, management consultancy services, technical testing, service incidental to mining, energy related scientific and technical consultancy, repair, transmission through pipeline etc. So, there are lot of scope for movement of FDI flow. Indonesia has opened up its MA through joint venture in energy related services and scope of FDI namely in management consultancy services, repair services, technical testing, and manufacture of coke, refined petroleum products and nuclear fuel on a fee or contract basis. Malaysia has also opened up its MA by allowing 51% FDI in engineering and integrated engineering services, management consulting services and technical testing. Singapore has fully liberalized its market in research and development services and allowed up to 51 per cent FDI in engineering services. The research also pointed out that there is a sufficient scope of energy cooperation among regional member countries within the three regional blocs, which enhanced regional integration and economic cooperation in the future.

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Reference

Aparna Sharma and Chetna K Rathore (2015), BIMSTEC and BCIM Initiatives and their Importance for India, *CUTS International Trade, Economics & Environment*, *2(1),* 2-15, http://www.cuts-citee.org/pdf/BIMSTEC_and_BCIM_Initiatives_and_their_Importance_for_India.pdf

[Arif Hussain Malik and Nazir Ahmad Sheikh (2016), *Changing Dynamics of Indo-Bhutan Relations*: *Implications for India, International Journal of Political Science and Development*, 4(2), 44-53, https://www.researchgate.net/publication/308991255_Changing_Dynamics_of_Indo-Bhutan_Relations_Implications_for_India

ADBI (2014), *ASEAN 2030 to wards a borderless economic community*, ADB 5(3), 43-169, https://www.adb.org/sites/default/files/publication/159312/adbi-asean-2030-borderless-economic-community.pdf

Hollweg, C., and M.-H. Wong.(2009). *Measuring Regulatory Restrictions in Logistics Services*. *Paper No. 2009-14. Jakarta: Economic Research Institute for ASEAN and East Asia, 3(1).* 4-22 https://ideas.repec.org/p/era/wpaper/d017.html

Ma, G., and E.M. Remolona. 2005. *Opening Markets through a Regional Bond Fund: Lessons from ABF2. BIS Quarterly Review,* June 6(3), pp. 81–92, https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.296.3043&rep=rep1&type=pdf

Stephen Thomsen, Misuzu Otsuka and Boram Lee (2011), *The Evolving Role of Southeast Asia in Global FDI Flows, The Institutfrançais des relations internationales (Ifri) centre for Asian studies*, 8(3), 6-29. https://www.ifri.org/sites/default/files/atoms/files/av40final.pdf

Burcak Polat (2018), *'BIMSTEC - A Vibrant Economic Bloc'*, MVIRDC world trade economic journal, 8(2),

31-117, https://wtcmumbai.org/pdf/report-presentiton/2018/BIMSTEC-5sep2018.pdf

Laura Diaconu (2014), *The foreign direct investments in South-East Asia during the last two decades , Elsevier and Procedia Economics and Finance*, 15 (3), 903 – 908. https://www.sciencedirect.com/

Deepti and Dr. Deepa Rawa (2015), *Role of FDI in Economic Development of India, Internationals Journal of Art & Humanity Science (IJAHS)*, 3(3),18-24, http://jirfp.com/journals/jirfp/Vol_2_No_2_June_2014/5.pdf

R.B. Teli (2013), *A critical analysis of foreign direct investment inflows in India, ScienceDirect, Procedia - Social and Behavioral Sciences* 13 (4) , 447–455. https://pdf.sciencedirectassets.com/277811/1-s2.0-S1877042814X00297/1-s2.0-S1877042814031218/main.pdf?X-Amz-Security-Token

Kallal Banerjee and Dipankar Dey (2017), *Trade in Energy Services under Different Regional Agreements BCIM, BIMSTEC+1 and ASEAN+4, International Journal of Latest Technology in Engineering, Management & Applied Science*, 6(12), 5-14, https://www.ijltemas.in/DigitalLibrary/Vol.6Issue12/01-22.pdf

Kallal Banerjee and Dipankar Dey (2018), *Trade in energy services in BCIM, BIMSTEC+1 and ASEAN+4 regions-potentials and Challenges, International journal of Management, IT and Engineering*, 8(2), 45-63, https://www.ijmra.us/project%20doc/2018/IJMIE_FEBRUARY2018/IJMRA-13355.pdf

Charu Lata Hogg (2007), *India and its neighbours: do economic interests have potential to build peace?, Royal Institute of International Affairs and International Alert*, 7(2), 2-13. https://www.international-alert.org/

D. S. Rawat and Sunil Kanoria (2016), *India ASEAN Trade and Investment Relations: Opportunities and Challenges, The Associated Chambers of Commerce and Industry of India*, 12(4), 5-54, https://theasiadialogue.com/wp-content/uploads/2018/03/ASEAN-STUDY.pdf

Dipankar Dey (2006), Bimstec-Japan: Investment Opportunities and Challenges, Social Science Research Network, 12(6), 5-41, https://carnegieendowment.org/files/CP_325_Xavier_Bay_of_Bengal_INLINE.pdf

Janaka Wijayasiri and Deshal De Mel (2008), *BIMSTEC-Japan Cooperation in Trade and Investment: A Sri Lankan Perspective, Centre for Studies in International Relations and Development (CSIRD)*, 8(2), 5-34, http://koha.ips.lk/cgi-bin/koha/opac-detail.pl?biblionumber=48205

United Nations Conference on Trade and Development and ASEAN (2017), *ASEAN Investment Report and Foreign Direct Investment and Economic Zones in ASEAN, ASEAN@50 community relation division*, 17-238. https://unctad.org/system/files/official-document/unctad_asean_air2017d1.pdf

UNCTAD (2013), *World Investment Report: Global Value Chains: Investment and Trade for Development*, 8(3), 87-125, https://unctad.org/system/files/official-document/wir2013_en.pdf

Zhaoli Wu (2014), *India Myanmar Bilateral Relation: cooperate actively and progress significantly,* Chapter 7, *Springer*, 155-169. https://www.springerprofessional.de/india-myanmar-bilateral-relations-cooperate-actively-and-progres/4398714

Sandra Polaski (2011), *Asia Pacific Review, Taylor and Francis ,Institute of Defence studies and Analysis*, 8(3), 67-95, https://www.science.gov/topicpages/a/abcg1-u2af1+region+reveals

[Brooks, Douglas, and H. Changchun. (2008). Asian Trade and Global Linkages. ADB Institute Working Paper No. 122. Tokyo: Asian Development Bank Institute. https://www.adb.org/sites/default/files/publication/155977/adbi-wp122.pdf

Calvo, G. (1998). *Capital Flows and Capital Market Crisis: The Simple Economics of Sudden Stops. Journal of Applied Economics* 1(11): 35–54. https://www.researchgate.net/publication/4928094_Capital_Flows_and_Capital-Market_Crises_The_Simple_Economics_of_Sudden_Stops

Chantasasawat, B., K.C. Fund, H. Iizaka and A. Siu.(2004). *Foreign Direct Investment in China and East Asia. Hong Kong Institute of Economics and Business Strategy* Working Paper No. 1135, The University of Hong Kong, November. Chinability. n.d. http://www.chinability.com/FDI.htm

Claessens, S., D. Oks and R. Polastri. (1998) , Capital Flows to Central and Eastern Europe and Former Soviet Union. Paper prepared for the NBER Study: Capital Inflows to Emerging Markets, 6(3), 8-40, https://www.nber.org/system/files/chapters/c6171/c6171.pdf

Cooper, R. (2006). *Living With Global Imbalances: A Contrarian View. Journal of Policy Modeling*. 2(8), 615–627. https://www.researchgate.net/publication/222752824_Living_with_Global_Imbalances_A_Contrarian_View

Demetriades, P. O. and B.A. Fattouh. (1999). The South Korean Financial Crisis: Competing Explanations and Policy Lessons for Financial Liberalization. International Affairs (Royal Institute of International Affairs) 7(5), 779–792.

Dennis, D.J. and Z.A. Yusof.(2003). *Developing Indicators of ASEAN Integration—A Preliminary Survey for a Roadmap.* REPSF Project 02/001, 34-112, http://aadcp2.org/file/02-001-Final-Report.pdf

M.B. and H. Genberg. (2007). Currency Appreciation and Current Account Adjustment. Journal of International Money and Finance. 26, 570–586.

Enders, W. (2004). Applied Econometric Time Series, East Asia: Issues and Challenges. Asian Development Bank ERD Working Paper No. 35. 17-36. Retrieved from: http://www.adb.org/Documents/ERD/Working_Papers/wp035.pdf.

Ferroni, M. (2004). *Regional Public Goods: The Comparative Edge of Regional Development Banks. Washington D.C.: Center for Global Development.* 8(9): 379–399. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.145.5092&rep=rep1&type=pdf

Kaminsky, G.L. and C.M. Reinhart. 1998. Financial crises in Asia and Latin America: Then and now. The American Economic Review 88(2): 444–448. Retrieved from the JSTOR database. http://www.oecd.org/dataoecd/43/7/33628756.pdf.

Karsenty, G. (2000):."Assessing trade in services by mode of supply", GATS 2000: New Directions in Services Trade Liberalisation, Brookings Institution, Washington DC, pp. 33.56.

Jamil, M. N. (2022). Critical Analysis of Energy Consumption and Its Impact on Countries Economic Growth: An empirical analysis base on Countries income level. *Journal of* Environmental *Science and Economics*, *1*(2), 1–12. https://doi.org/10.56556/jescae.v1i2.11

Michael P. Barry (2009), Foreign Direct Investments in Central Asian Energy: A CGE Model, Eurasian Journal of Business and Economics 2009, vol 2 (3), pp no 35-54, http://www.ejbe.org/EJBE2009Vol02No03p35BARRY.pdf

Hikari Ishido (2012), Liberalization of Trade in Services under ASEAN+n FTAs: A Mapping Exercise, Journal of East Asian Economic Integration Vol. 16, No. 2, pp 1-56.

International Renewable Energy Agency, IRENA(2018), Renewable Energy Market Analysis: Southeast Asia, iberglobal, pp 21-147, http://www.iberglobal.com/files/2018/IRENA_Market_Southeast_Asia_2018.pdf (last accessed 27/11/2021)

Joachim Monkelbaan (2013), Trade in sustainable energy services**,** International Centre for Trade and Sustainable Development (ICTSD), pp 5-71, https://www.ictsd.org/sites/default/files/downloads/2013/12/seta-ita_sust_energy.pdf (last accessed 29/9/2021)

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RESEARCH ARTICLE

Orientation as a panacea for improving the Thermal Performance of a fully enclosed courtyard in a typical tropical climate

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Abstract
Globalization has resulted in pollution, carbon emissions, climate change, and an insufficient supply of natural resources. As a result, research is required to increase the thermal performance of buildings. In this regard, using a courtyard as a building component is one of the most sustainable ways to improve the building's thermal performance and microclimate. While utilizing the Envi-met program on the configurations chosen for the fully enclosed courtyard, this study investigated the effect of orientation on the fully enclosed courtyard's thermal performance. 1:1:1 and 1:2:1 are examples of this setup. The orientations considered in this example were N-S, E-W, NE-SW, and NW-SE. The air temperature, mean radiant temperature and physiological equivalent temperature were measured during simulations of two configurations of the fully enclosed courtyard. According to the research, the air temperature, mean radiant temperature and physiological equivalent temperature rises as the size of the courtyard grows. As a result, the air temperature in the 1:1:1 courtyard arrangement is lower than in the 1:2:1 courtyard design.

Keywords: Courtyard; Simulation; Orientation; Air temperature and Mean Radiant Temperature

Introduction

Globalization has been linked to environmental pollution, carbon emissions, climate change, rising energy demand, and a scarcity of natural resources, according to numerous research (Behrens et al., 2007; Rasul and Sharma, 2016; Wang et al., 2018). Over 30% of carbon emissions, which are the primary cause of climate change, are reflected in the thermal performance of buildings (Wang et al., 2018).
Therefore, it is necessary to conduct studies to improve the thermal performance of buildings. In this context courtyard as a building component is one of the sustainable strategies to checkmate the thermal performance and improve the microclimate of the building. The use of courtyards in buildings solves a variety of issues, including seclusion, comfort, and reduced energy consumption. The courtyard also provides natural ventilation, lighting, and thermal performance. According to Meir et al. (1995), using courtyard constructions as a microclimatic modifier has been considered for decades. The solution to the issue of thermal performance focused on finding effective passive strategies. The outcome of this step that the designers became more aware of traditional strategies that depend on non-mechanical methods, in order to improve the comfortable atmosphere. For an example in hot-dry and warm-humid zones cooling is a priority than heating, for this demand many elements support natural techniques applied in these buildings for many decades, such as courtyards, mashrabiyya, wind towers and ventilation tunnel (Allen G. Noble, 2007; Rajapaksha et al., 2003; Zain,2012). Rajapaksha et al., (2003) in their study focused on the cooling techniques around the building, they found that in warm-humid regions, vernacular design techniques involved elements in providing a cooling environment such as courtyard, building orientation, shading device, while in the United State of America, a ventilation tunnel is accessible in the region. In Middle Eastern countries mashrabiyya and ventilation through water elements used in a humid area, whereas in the tropics they used courtyard

For generations, the courtyard has served as a utilitarian and symbolic architectural element. The courtyard concept is employed in every part of the world. "A court open to the sky, especially one enclosed on all four sides," McKean (2006) defined courtyard. However, different scholars have varied meanings of the courtyard. According to Abass et al. (2016), a courtyard is a covered outdoor space that is open to the elements at its apex, but Zakaria and Kubota (2014) defined it as an open chamber into the skies that is bordered by buildings or rooms. Taleghani et al., (2014), on the other hand, describe the courtyard as an outdoor place that is virtually interior, exposed to the sky, in contact with the ground, yet surrounded by rooms. Yaşa and Ok (2014) defined courtyard as an open space surrounded by vertical components or structures. Berkovic et al. (2012) also refer to the courtyard as a part of a house that serves as an internal open space surrounded by pleasant rooms. Some words appear often in all meanings, including 'open, "space,' 'enclosed,' and 'wall. 'As a result, a courtyard can be defined in this context as an area within a building that is wholly or partially internal and exposed to the sky.

The use of courtyard in Malaysia dates back to the era of indigenous architecture. In this case, the traditional Malay home in Melaka (one of Malaysia's oldest cities) was modified by the influence of Chinese traditional architecture by incorporating enclosed courtyards (Makaremi et al., 2012; Ghaffarianhoseini et al., 2015). There is a strong interest in the usage of courtyard in many architecture structures in Malaysia nowadays, including residential, educational, and health care.

The orientation of outdoor spaces should be possible in such a way that adequate airflow is maintained, resulting in a cooling effect during the hot summer days. It's important to note the wind factor before conducting the orientation because too much wind can be uncomfortable in an outdoor setting. It is one of the most important aspects influencing the air temperature in an outdoor environment, necessitating extra research in addition to temperature studies. Another important aspect that is Influenced by spatial orientation is solar radiation exposure.

Literature review

Another key aspect that is influenced by space orientation is space exposure to solar radiation. Shading can improve thermal comfort levels; however, solar exposure levels degrade on the other side. For the transfer of temperature on surfaces and the accumulated solar energy assimilated in a certain period and space, the direction of space is far more important than the retained quantity. According to Ali-Toudert & Mayer (2006a), the temperature stress in E-W canyon was higher than in N-S canyon, resulting in improved thermal comfort. The shading coefficient expands in this way in NESW and NWSE orientations, resulting in improved comfort levels with little difference between the two. According to Haggag & Elmasry (2011), the SENW hub can receive cooling breezes and provide shading, reducing thermal loads in structures.

The orientation factor is not that successful concerning air temperature deviation when contrasted with W/H ratio of the space. Orientations that have high solar exposure require further spaces (Large H/W ratio) then again orientations that experience less exposure to solar radiation can have wider spaces (littler H/W ratios). The primary basis of orientation is the collaboration of built forms with respect to sun angle and prevailing wind direction. Despite the fact that there are conflicts between proficient prevalent wind orientation and solar orientation that must be considered in the site-by-site evaluation. Controlling the layout of the urban fabric in terms of roadways and plot shape also transmits appropriate orientation. As previously said, traditional short streets and reduced form design diminish sun exposure and increase shading impact, darkening the East and West exteriors of North-South oriented streets.

Muhaisen (2006) evaluated the effect of changing the orientation, following Muhaisen (2006)'s prior investigation of the geometrical courtyard form linked to environmental performance in various climatic zones. Because the internal walls are always vertical, the orientation of the single surfaces would change. As a result, some walls are always in the shadow while others are exposed to solar radiation, reducing the thermal performance. The experience of the greatest shaded area is influenced by climatic conditions and location. As a result, Muhaisen rotated the courtyard to study the influence of orientation. According to Muhaisen (2006), positioning the courtyard long axis between the North-South axis and the Northeast-Southwest axis determines effective courtyard performance throughout the year. According to the Muhaisen theory, the sun passes overhead for places around the equator, resulting in the east and west walls receiving the maximum solar radiation. Most modern buildings, according to Soflaei et al. (2016), were designed without enough attention for environmental implications. The courtyard is built to allow direction, dimensions, and proportion to serve as climatic modifiers, according to their research. Similarly, Al-Hafith et al. (2017) carried out an experimental investigation to evaluate the impact of orientation and geometry on shading; their findings show that geometry and orientation have a substantial impact on shading level. They proposed a regression equation for predicting the shade level of various courtyard shapes throughout the year.

In their study in Kuala Lumpur, Malaysia, Ghaffarianhoseini et al. (2015) found that the right location and orientation of courtyards could result in more wind and more shade throughout the day. As a result, it is an important aspect in improving outdoor thermal comfort. According to simulations, the courtyard facing north has somewhat better thermal performance, with a minimum air temperature of 27°C at 8:00 and a maximum air temperature of 32°C at 15:00. As a result, the purpose of this article is to determine

the impact of orientation on the performance of a fully enclosed courtyard in a hot, humid climate.

Thermal performance of courtyard was analysed by Aldawoud (2008), Moonen et al. (2011), Muhaisen (2006), Muhaisen & Gadi (2006) and Safarzadeh & Bahadori (2005). Whereas vegetation effect was analysed in some studies:(Ghaffarianhoseini et al., 2015; Haggag et al., 2014; Mangone et al., 2014; Park et al., 2012; Shashua-Bar et al., 2011). Past studies were directed on the courtyard and their impacts, the majority of these studies were focused on hot-dry climate. Studies on courtyard building in the tropics are limited because the focus on buildings in Malaysia is based on terraced houses and high rise buildings.(Almhafdy et al., 2013;

Ghaffarianhoseini et al., 2015; Kubota et al., 2014, 2017; Rajapaksha et al., 2003;Tablada and Blocken, 2005; Zakaria and Kubota, 2014). Therefore, a gap in knowledge is identified, and there is a need to bridge the gap. This study intends to bridge the gap in knowledge.

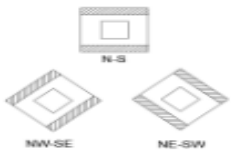
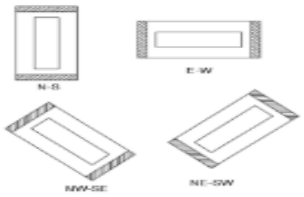
Methods and Material

The influence of orientation on a fully enclosed courtyard with a 15-meter-high wall in a hot humid climate is the topic of this research. The study's major parameters were identified as environmental microclimate characteristics such as air temperature, mean radiant temperature, and physiological equivalent temperature. It motivates a study into the effect of orientation on thermal performance in order to improve the completely enclosed courtyard microclimate, which influences the fully enclosed courtyard's indoor condition.

The week of the 11th to the 17th of July 2017 was chosen for checking and capturing meteorological data from the fully enclosed courtyard at Universiti Teknologi Malaysia's Raja Zarith Sofiah Library. To demonstrate the study, data from a typical sunny day on July 16, 2017 was chosen to be used as input for simulation and detail analysis. Numerical simulation is used to achieve the study goal. For the simulation, Yaşa and Ok (2014) proposed courtyard ratio models (Sadafi et al. 2011; Ghaffarianhoseini et al. 2015; Muhaisen 2006). The models are based on the courtyard from the case study. 1: 1: 1 was the assumed courtyard ratio (height: length: width). This courtyard ratio is 15m: 15m: 15m.

Table 1 shows the courtyard configurations A and B. The following is a full description of the simulation process: The surface covering for configuration A (15m x 15m x 15m) with a courtyard ratio of 1:1:1 (H: L: W) was 100 percent concrete. The North-South (N-S) direction, the Northeast-Southwest (NE-SW) orientation, and the Northwest-Southeast (NW-SE) orientation are the three orientations to examine in this context. In the instance of configuration B (15m x 30m x 15m), which has a courtyard ratio of 1:2:1 (H: L: W), the surface finish was 100 percent concrete, and it has four orientations in total: North-South (N-S), East West (E-W), Northeast – Southwest (NE-SW), and Northwest – Southeast (NW-SE).

Table 1: Table showing a detailed simulation test case

SN	Configuration	Dimension(m)	Courtyard ratio (H:L: W)	Surface covering	Orientation	Total simulation
1	A	15m x 15m x 15m	1:1:1	100% concrete		3
2	B	15m x 30 x 15m	1:2:1	100% concrete		4

Results and Discussion

One of the key variables in heat mitigation has been identified as orientation. The effect of orientation on the thermal performance of the courtyard has been studied extensively (Ghaffarianhoseini et al., 2015; Muhaisen, 2006). The effect of orientation on the thermal performance of fully enclosed courtyard designs is examined in this section.

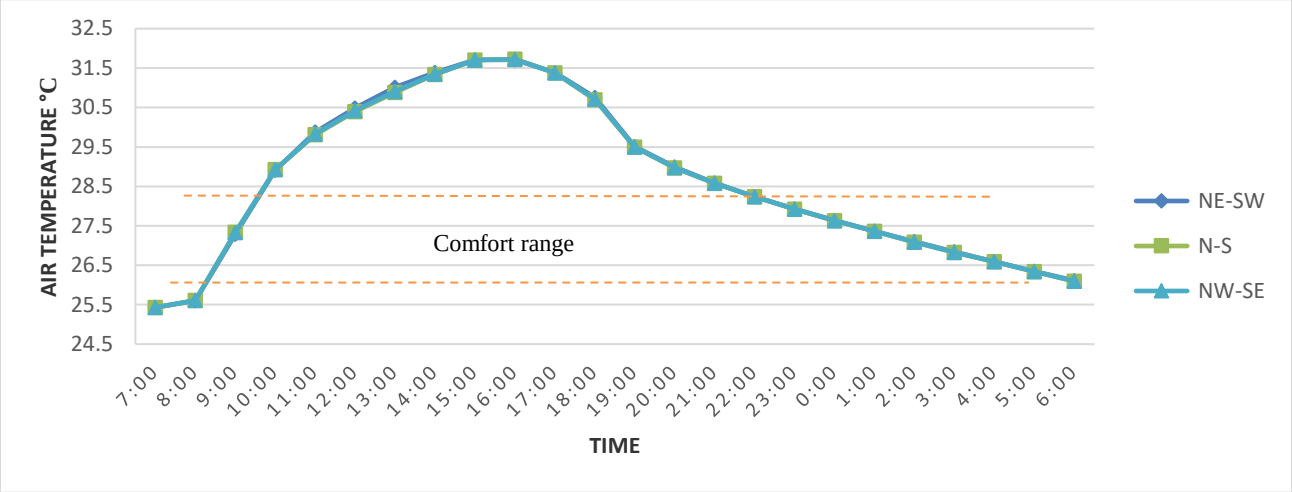


Figure 1: Variation in the air temperature of the courtyard ratio 1:1:1for different orientation.

The air temperature in this scenario ranges from 25.41°C to 31.73°C. The influence on air temperature begins at 07:00 and gradually increases until it reaches its peak at 16:00. As a result, the impact begins to fade gradually (around 19.00 hours) in the evening. A minimum air temperature of 25.43°C (07:00) and a maximum air temperature of 31.73°C were recorded in the N-S orientation (most extended length facing East).

This implies that the courtyard is hotter on the N-S orientation because a larger portion of the courtyard is exposed to sun radiation throughout the day.

The NE-SW orientation recorded a minimum of 25.41°C (in this case, the most extended length, is inclined at an angle of 45° and faces east direction), exposing a larger portion of the courtyard to solar radiation. However, the NW-SE orientation recorded the least through the courtyard, recording a minimum of 26.19°C and a maximum of 31.54°C, due to the fact that the NW-SE orientation is inclined at an angle of 45° and faces west direction, which is far.

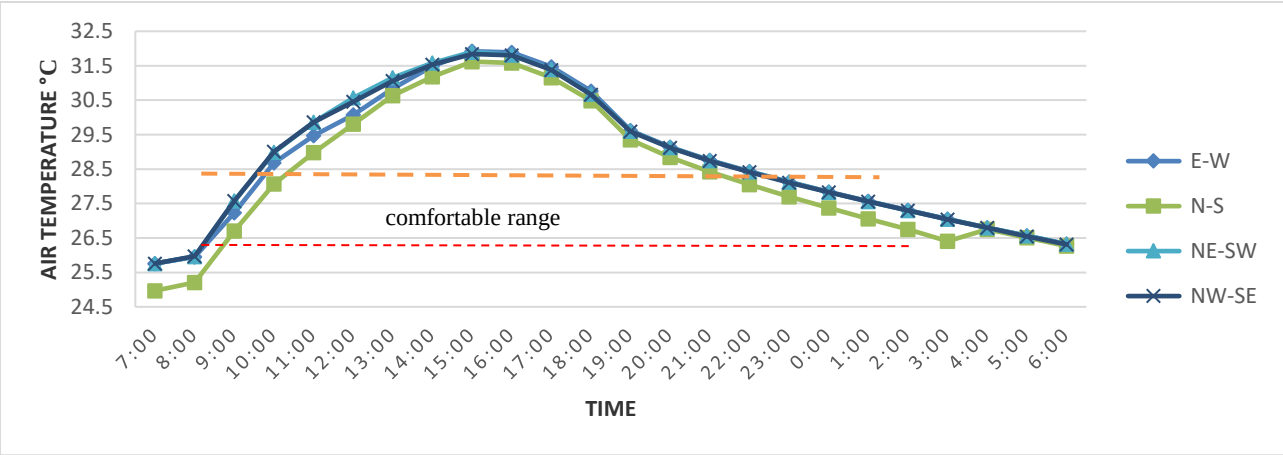


Figure 2: Variation in the air temperature of the courtyard ratio 1:2:1for different orientation

Figure 2 depicts the fluctuations in air temperature for the courtyard ratio 1:2:1 during the course of 24 hours. The temperature ranges from 25.76°C to 31.92°C in the air. Hourly temperatures begin to increase at 7:00 a.m. and peak between 13:00 and 17:00 a.m., with the greatest point at 15:00 p.m., after which the temperature begins to fall at 19:00 p.m. The courtyard with the E-W orientation (shorter side facing East, longest side facing North) recorded a minimum temperature of 25.7°C (at 07.00) and a maximum air temperature of 31.95°C (at 15:00), eventually the highest air temperature recorded, due to the courtyard space being exposed to solar radiation more than the other orientations.

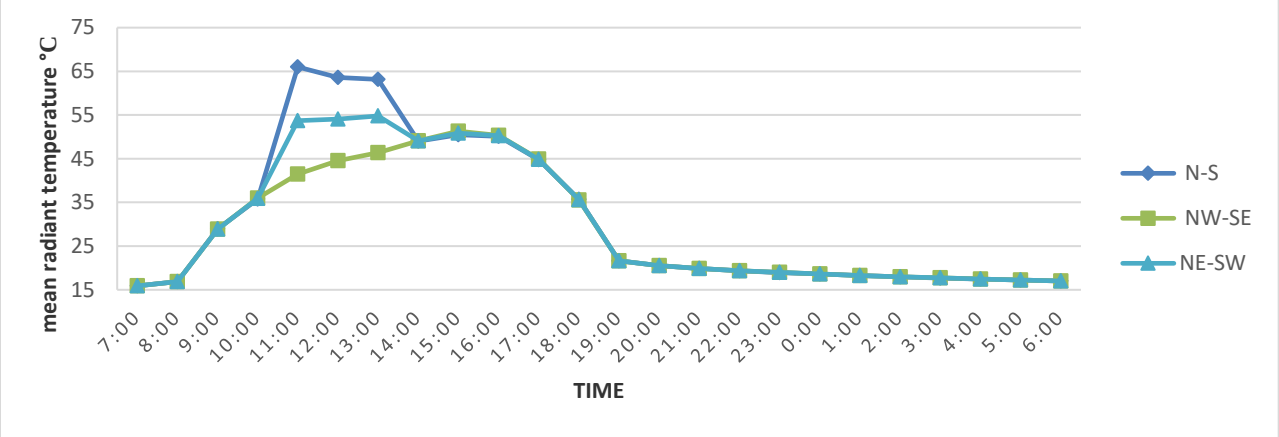


Figure 3: Variation in the mean radiant temperature of the courtyard ratio 1:1:1for different orientation.

Figure 3 depicts the hourly fluctuation in the mean radiant temperature of the courtyard ratio 1:1:1 over a 24-hour period. The average radiant temperature is between 15.90 and 66 degrees Celsius. Starting at 8:00 a.m., greater values of mean radiant temperature were recorded until it peaked at 10:00 a.m. to 13:00 a.m., and then moved farther from 13:00 a.m. to 15:00 a.m. Convection and radiant heat loss contribute to the mean radiant temperature. The behavior of the courtyard configuration 1:1:1 from 10:00 to 13:00, where NW – SE recorded a lower mean radiant temperature than N – S and NE – SW, was owing to the courtyard's shading effect, as shown in figure 3.0.

The radiant interaction affects mean radiant temperature. Figure 4.0 depicts the hourly variation of mean radiant temperature over a 24-hour period. The minimum and maximum mean radiant temperatures are 15.97°C and 72.96°C, respectively. Starting at 08.00, greater values of radiant were recorded till it reached its peak at 10.00 to 13.00, after which it shot up to its greatest from 13.00 to 15.00, owing to early daytime when the highest solar radiation was recorded, as well as the sun angle being at 90° at the peak hour. Due to the sun's low altitude, the mean radiative temperature begins to drop at 17.00. The minimum mean radiant temperature in the E-W orientation was 15.97°C, with a maximum of 72.96°C, while the minimum mean radiant temperature in the N-S orientation was 15.15°C, with a maximum of 72.96°C. While the minimum mean radiant temperature was 15.97°C and the maximum was 72.95°C in the NE-SW direction.

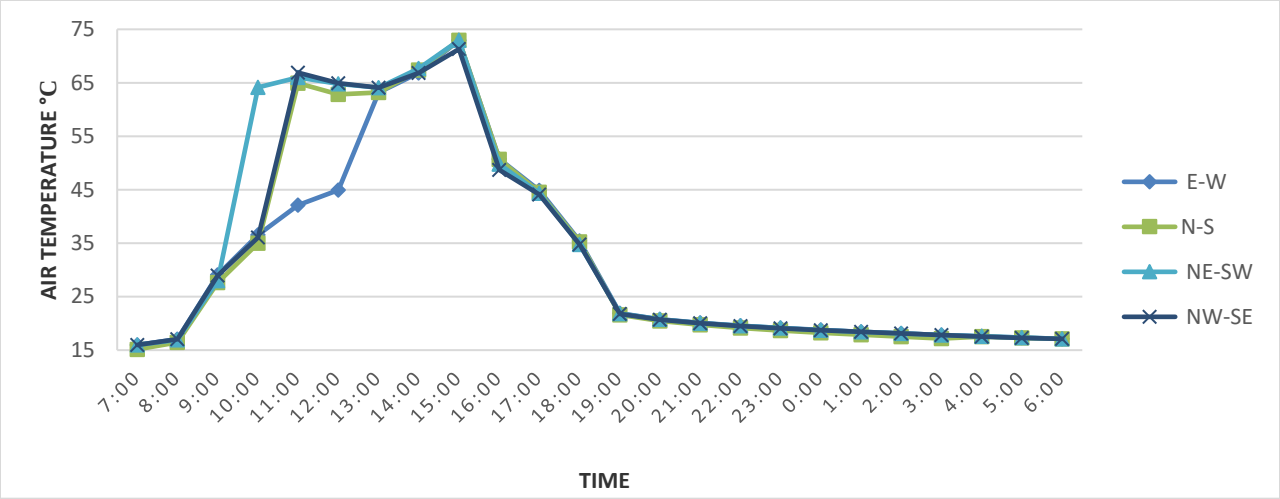


Figure 4: Variation in the mean radiant temperature of the courtyard ratio 1:2:1for different orientation

Figure 5.0 depicts the Physiological Equivalent Temperature's hourly changes (PET) of courtyard ratio 1:1:1. The PET has a temperature range of 20.10°C to 44.2°C. The higher estimates of Psychological Equivalent Temperature were observed starting at 08:00 and continuing until the crest around 10:00 to 13:00. This was due to the early morning hours, when the most incredible radiation was recorded, as well as the time when the sun angle hits 90. N – S orientation, meaning the most significant side is facing east, with a PET of 20.10, and a maximum of 44.2°C. Minimum PET of 20.10 and a maximum PET of 39.90°C in the NE–SW. NW – SE, on the other hand, had the lowest PET of 20.10°C and the highest of 39.00, meaning that it is the lowest of the other orientations. This is due to the NW – SE orientation, which causes the west direction to fail away from the east direction, as well as the shading.

Figure5 shows that from 10:00 to 14:00, the NW – SE orientation had a lower PET than the N – S and NE – SW orientations. The behaviour is due to the courtyard's shading effect.

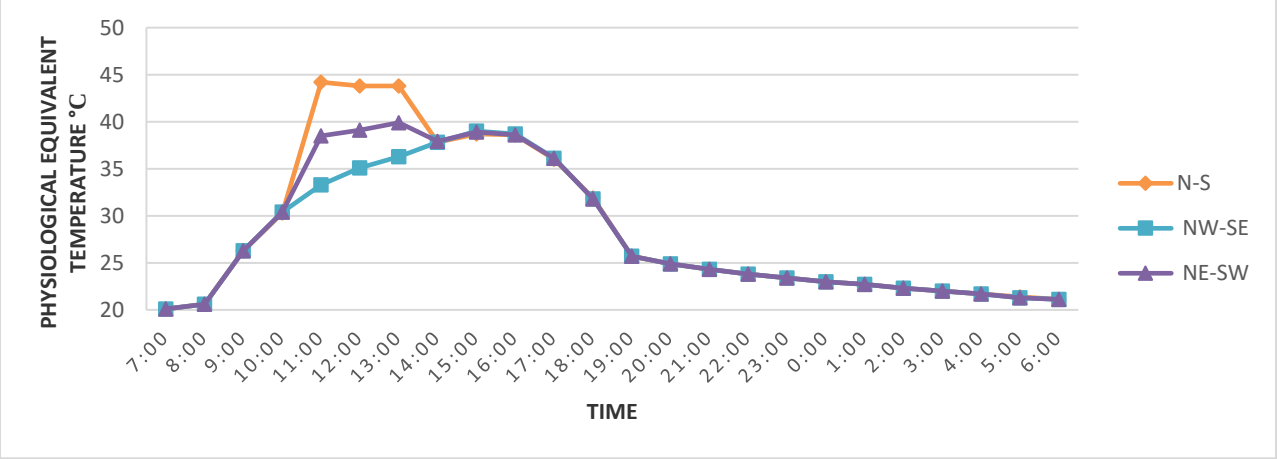


Figure 5: Variation in the physiological equivalent temperature of the courtyard ratio 1:1:1for different orientation.

The hourly change of physiological equivalent temperature can be shown in Figure 6. Temperatures in the physiological equivalent range from 20.5°C to 49.9°C. Starting at 08:00, increased levels of physiological equivalent temperature were recorded until it peaked between 10:00 and 13:00, with a rise between 13:00 and 15 hours. This was due to the fact that the first radiation was detected early in the day, during the peak hour of the sun angle, which is at 90 degrees. The N–S and E–W orientations both recorded the same minimum and maximum physiological equivalent temperatures of 20.50°C and 49.40°C, respectively, whereas the NE–SW orientation recorded a minimum PET

of 20.50°C and a maximum of 49.30°C. Following that, the NW-SE orientation had a minimum PET of 20.50°C and a maximum of 48.40°C. This indicates that NW-SE performed better thermally since it had the lowest PET, as indicated in Table 4.3. The physiological equivalent temperature of a specific outdoor or indoor environment is equivalent to the air temperature where the indoor setting is typical (v = 0.1m/s, water pressure = 12hpa, and Mrt = air temperature), the human body's heat balance is maintained, and core and skin temperatures are equal to those under the condition being assessed. This is relevant in this study because the tenant of the totally enclosed courtyard will be able to compare the effects of the complicated thermal conditions outside with his or her own internal experience.

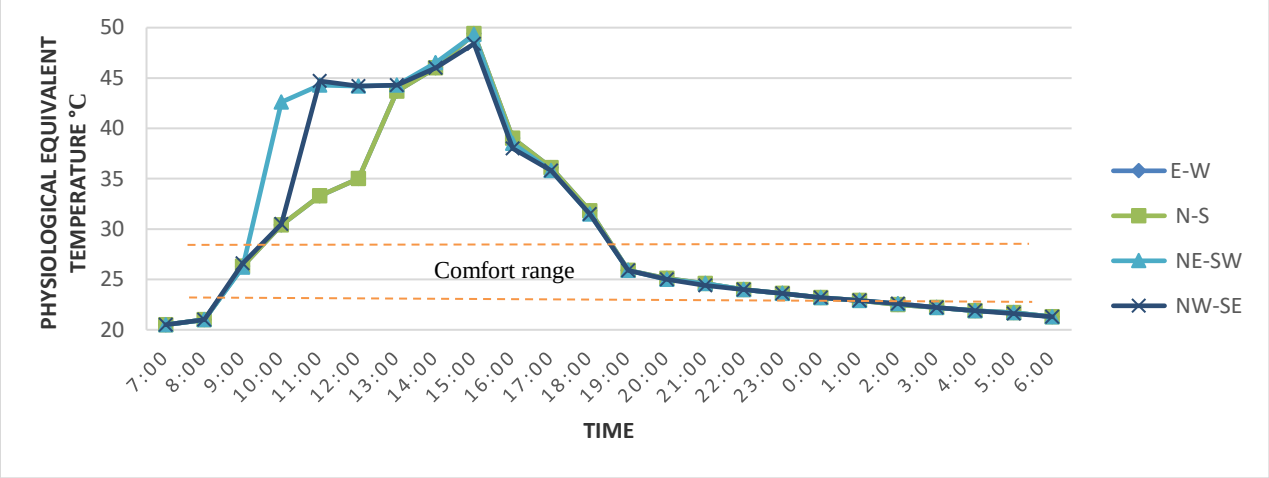


Figure 6: Variation in the physiological equivalent temperature of the courtyard ratio 1:2:1for different orientation.

The effect of courtyard orientation on thermal performance has not been thoroughly investigated. The purpose of this research is to see how the orientation of courtyards affects their thermal performance. The research was founded on the assumption that the courtyard's orientation has both positive and negative effects on its thermal performance. As a result, in this context, courtyard arrangements configuration with a height of 15 meters were studied. Manipulate the configurations with a fixed length of 15 meters in various orientations to improve the courtyard microclimate. The study looked at how different orientations affect the courtyard microclimate, such as shadowing and sun angle.

The air temperature, mean radiant temperature, and physiological equivalent temperature increased as the size of the courtyard configuration increased, according to the analysis. This suggests that as the courtyard is exposed to more solar radiation, the shading level of the courtyard diminishes. Inferring that the greater the thermal performance, the smaller the courtyard configuration.

According to the research, the courtyard configuration 1:1:1 has the optimum performance in terms of air temperature in all orientations. This is because the courtyard configuration 1:1:1 is the smallest and receives the most shade from the walls that surround the courtyard perimeter. In comparison to other courtyard arrangements, this reduces solar radiation exposure, lowering air temperature. In terms of mean radiant temperature, courtyard configuration 1:1:1 performed best in NE – SW and NW- SE orientations, whereas courtyard configuration 1:2:1 performed best in N – S and E – W orientations (Mrt). This is due to the fact that as the sun's angle varies, the mean radiant temperature changes as well. The courtyard 1:1:1 was found to be the most effective in reducing Mrt, with Mrt reduced by 11.20°C for NE – SW direction and 14.7°C for NW – SE orientation. Similarly, for N – S and E – W orientations, the 1:2:1 design performed best, with Mrt lowered by 0.81°C. This is about the sun's angle.

The study also discovered that as the ambient temperature rises, the physiological equivalent temperature (PET) rises as well. PET is the air temperature at which a person's heat budget in an indoor context is balanced with their skin temperature in an outside environment. The simulation approach revealed that mean radiant temperature, rather than air temperature, influenced the variance of the thermal index PET, demonstrating that air temperature is insufficient for evaluating thermal performance in a fully enclosed courtyard. Due to shading from the walls and self-shading of the totally enclosed courtyard, PET values for protection from direct sun radiation have decreased. This result is consistent with Ali-Toudert and Mayer's research (2006) and Muhaisen (2006).

Conclusion

The influence of orientation on the courtyard's thermal performance was validated using the Envi-met software on the fully enclosed courtyard configuration chosen for this

study. 1:1:1 and 1:2:1 are examples of this setup. The orientations considered in this example were N-S, E-W, NE-SW, and NW-SE. The air temperature, mean radiant temperature and physiological equivalent temperature was measured during simulations of two configurations of the totally enclosed courtyard.

According to the research, the air temperature, mean radiant temperature and physiological equivalent temperature rises as the size of the courtyard grows. So et al. (2017) and Taleghani et al. (2014) both validated that the 1:1:1 courtyard configuration had a lower air temperature than the 1:2:1 courtyard configuration.

The configuration 1:1:1, and1:2:1, reveals that E- W orientation recorded the highest air temperature, mean radiant temperature and physiological equivalent temperature. While the NW-SE orientation had lowest air temperature, mean radiant temperature, and physiological equivalent temperature. The courtyard configuration 1:1:1 performed better in NE – SW and NW – SE with a reduction in PET by 4.3°C, while courtyard configuration 1:2:2 performed better in N – S and E – W orientation with a reduction in PET by 0.2°C and 0.3°C respectively.

References

Abbaas, E. S., Saif, A. A., Munaaim, M., & Othuman Mydin, M. A. (2018). Influence of Courtyard Ventilation on Thermal Performance of Office Building in Hot-Humid Climate: A Case Study. In E3S Web of Conferences (Vol. 34, pp. 1–8). https://doi.org/10.1051/e3sconf/20183402053

Aldawoud, A. (2008). Thermal performance of courtyard buildings. *Energy and Buildings*, *40*(5), 906–910. https://doi.org/10.1016/j.enbuild.2007.07.007

Al-Hafith, O., Satish, B. K., Bradbury, S., & De Wilde, P. (2017). The Impact of Courtyard parameters on its shading level an experimental study in Baghdad, Iraq. Energy Procedia, 134, 99–109. https://doi.org/10.1016/j.egypro.2017.09.539

Ali-Toudert, F., & Mayer, H. (2006). Numerical study on the effects of aspect ratio and orientation of an urban street canyon on outdoor thermal comfort in hot and dry climate. Building and Environment, 41(2), 94–108. https://doi.org/10.1016/j.buildenv.2005.01.013

Allen G. Noble. (2007). *Traditional Buildings*. I.B.Tauris & Co Ltd 6 Salem Road, London W2 4BU 175 Fifth Avenue, New York NY 10010 www.ibtauris.com.

Almhafdy, A., Ibrahim, N., Ahmad, S. S., & Yahya, J. (2013). Analysis of the Courtyard Functions and its Design Variants in the Malaysian Hospitals. *Procedia - Social and Behavioral Sciences*, *105*, 171–182. https://doi.org/10.1016/j.sbspro.2013.11.018

Behrens, A., Giljum, S., Kovanda, J., & Niza, S. (2007). The material basis of the global economy worldwide patterns of natural resource extraction and their implications for sustainable resource use policies, 4. https://doi.org/10.1016/j.ecolecon.2007.02.034

Berkovic, S., Yezioro, A., & Bitan, A. (2012). Study of thermal comfort in courtyards in a hot arid climate. Solar Energy, 86(5), 1173–1186. https://doi.org/10.1016/j.solener.2012.01.010

Haggag, M. A., & Elmasry, S. K. (2011). Integrating passive cooling techniques for sustainable building performance in hot climates with reference to the UAE. WIT Transactions on Ecology and the Environment, 150, 201–212. https://doi.org/10.2495/SDP110181

Haggag, M., Hassan, A., & Elmasry, S. (2014). Experimental study on reduced heat gain through green façades in a high heat load climate. *Energy and Buildings*, *82*, 668–674. https://doi.org/10.1016/j.enbuild.2014.07.087

Ghaffarianhoseini, A., Berardi, U., & Ghaffarianhoseini, A. (2015). Thermal performance characteristics of unshaded courtyards in hot and humid climates. *Building and Environment*, *87*, 154–168. https://doi.org/10.1016/j.buildenv.2015.02.001

Kubota, T., Hooi, D., Toe, C., & Ossen, D. R. (2014a). Field Investigation of Indoor Thermal Environments in Traditional Chinese Shophouse with Courtyards in Malacca Malaysia, using field measurements and focuses on the cooling effects of courtyards . *Journal of Asian Architecture and Building Engineering*, *13*(1), 2–9.

Mangone, G., Kurvers, S. R., & Luscuere, P. G. (2014). Constructing thermal comfort: Investigating the effect of vegetation on indoor thermal comfort through a four season thermal comfort quasi-experiment. *Building and Environment*, *81*, 410–426. https://doi.org/10.1016/j.buildenv.2014.07.019

Makaremi, N., Salleh, E., Jaafar, M. Z., & GhaffarianHoseini, A. (2012). Thermal comfort conditions of shaded outdoor spaces in hot and humid climate of Malaysia. Building and Environment, 48, 7–14. https://doi.org/10.1016/j.buildenv.2011.07.024

McKean, E. (2006). Concise Oxford American Dictionary. (E. McKean, Ed.) (First, Edit). Oxford University Press.

Muhaisen, A. S. (2006). Shading simulation of the courtyard form in different climatic regions. Building and Environment, 41(12), 1731–1741. https://doi.org/10.1016/j.buildenv.2005.07.016

Meir, I. a., Pearlmutter, D., & Etzion, Y. (1995). On the microclimatic behaviour of two semi-enclosed attached courtyards in a hot dry region. Building and Environment, 30(4), 563–572. https://doi.org/10.1016/0360-1323 (95)00018-2

Moonen, P., Dorer, V., & Carmeliet, J. (2011). Evaluation of the ventilation potential of courtyards and urban street canyons using RANS and LES. *Journal of Wind Engineering and Industrial Aerodynamics*, *99*(4), 414–423. https://doi.org/10.1016/j.jweia.2010.12.012

Park, M., Hagishima, A., Tanimoto, J., & Narita, K. (2012). Effect of urban vegetation on outdoor thermal environment: Field measurement at a scale model site. *Building and Environment*, *56*, 38–46. https://doi.org/10.1016/j.buildenv.2012.02.015

Rajapaksha, I., Nagai, H., & Okumiya, M. (2003). A ventilated courtyard as a passive cooling strategy in the warm humid tropics. *Renewable Energy*, *28*(11), 1755–1778. https://doi.org/10.1016/S0960-1481 (03)00012-0

Rasul, G., & Sharma, B. (2016). The nexus approach to water – energy – food security: an option for adaptation to climate change an option for adaptation to climate change. Climate Policy, 16(6), 682–702. https://doi.org/10.1080/14693062.2015.1029865

Sadafi, N., Salleh, E., Haw, L. C., & Jaafar, Z. (2011). Evaluating thermal effects of internal courtyard in a tropical terrace house by computational simulation. Energy and Buildings, 43(4), 887–893. https://doi.org/10.1016/j.enbuild.2010.12.009

Safarzadeh, H., & Bahadori, M. N. (2005). Passive cooling effects of courtyards. *Building and Environment*, *40*(1), 89–104. https://doi.org/10.1016/j.buildenv.2004.04.014

Shashua-Bar, L., Pearlmutter, D., & Erell, E. (2011). The influence of trees and grass on outdoor thermal comfort in a hot-arid environment. *International Journal of Climatology*, *31*(10), 1498–1506. https://doi.org/10.1002/joc.2177

So, F., Shokouhian, M., & So, A. (2017). Traditional courtyard houses as a model for sustainable design : A case study on BWhs macroclimate of Iran. https://doi.org/10.1016/j.foar.2017.04.004

Soflaei, F., Shokouhian, M., & Mofidi Shemirani, S. M. (2016). Traditional Iranian courtyards as microclimate modifiers by considering orientation, dimensions, and proportions. Frontiers of Architectural Research. https://doi.org/10.1016/j.foar.2016.02.002

Tablada, A., & Blocken, B. (2005). The influence of courtyard geometry on air flow and thermal comfort: CFD and thermal comfort simulations. *PLEA2005 - The 22nd Conference on Passive and Low Energy Architecture*. (November), 13–16.

Taleghani, M., Tenpierik, M., & van den Dobbelsteen, A. (2014). Indoor thermal comfort in urban courtyard block dwellings in the Netherlands. Building and Environment, 82, 566–579. https://doi.org/10.1016/j.buildenv.2014.09.028

Wang, N., Phelan, P. E., Harris, C., Langevins, J., Nelson, B., & Sawyer, K. (2018). Past visions, current trends, and future context: A review of building energy, carbon, and sustainability. Renewable and Sustainable Energy Reviews, 82(January 2016), 976–993. https://doi.org/10.1016/j.rser.2017.04.114

Yaşa, E., & Ok, V. (2014). Evaluation of the effects of courtyard building shapes on solar heat gains and energy efficiency according to different climatic regions. Energy and Buildings, 73, 192–199. https://doi.org/10.1016/j.enbuild.2013.12.042

Zain, Z. (2012). The Structural System of Traditional Malay Dwellings in Sambas Town West Kalimantan, Indonesia. *International Journal of the Malay World and Civilisation*, *30*(1), 139–158.

Zakaria, M. A., & Kubota, T. (2014). Environmental Design Consideration for Courtyards in Residential Buildings in Hot-humid Climates: A Review, 1(1), 45–51.